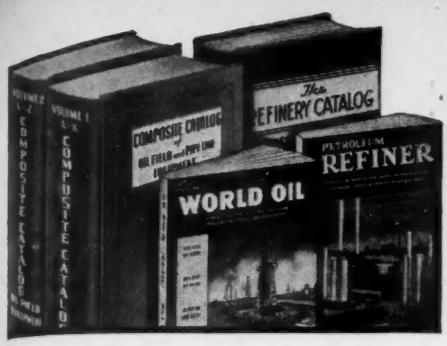

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WORLD OIL and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

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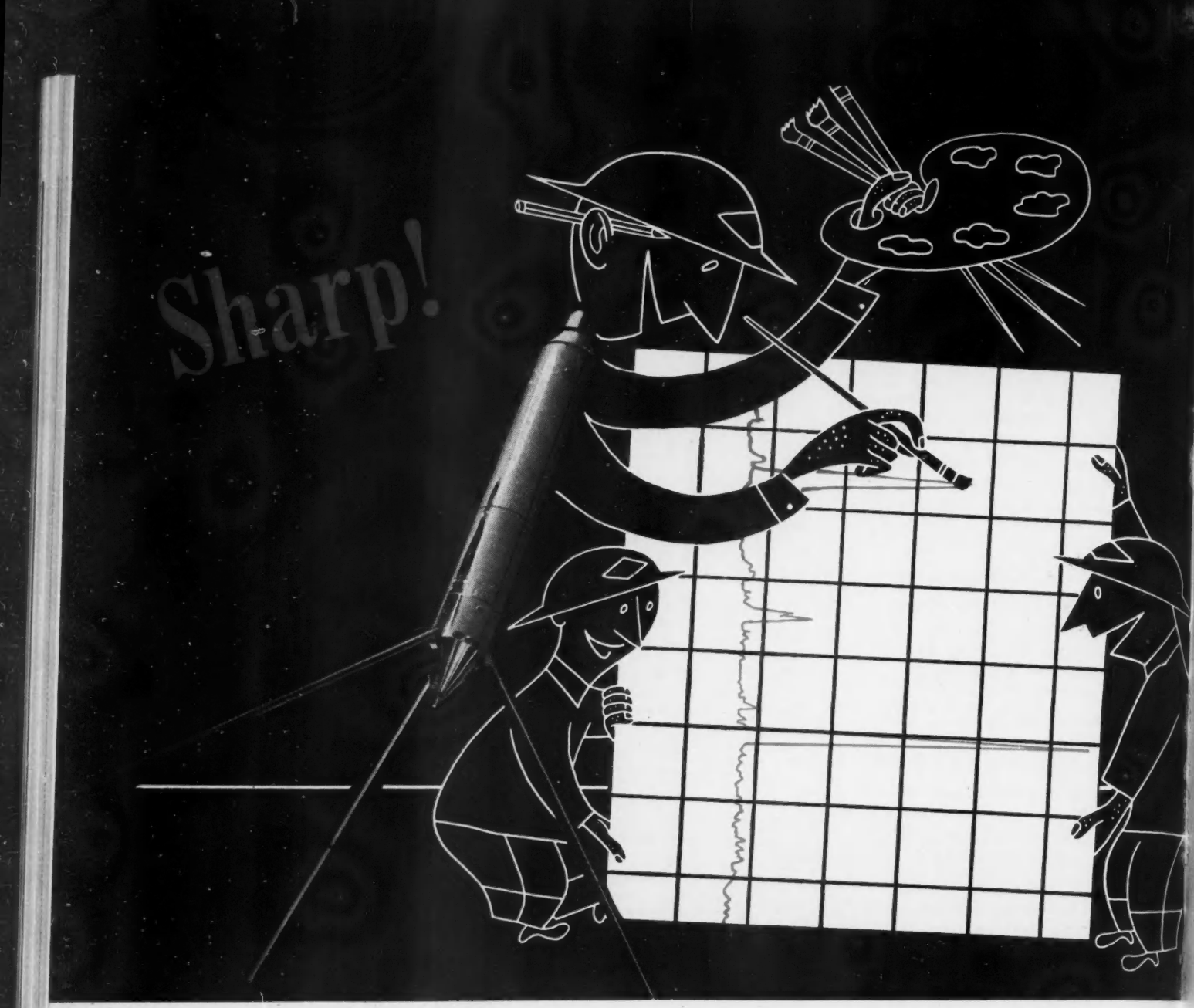

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NINETY YEARS OF PROGRESS

THE PETROLEUM INDUSTRY was born 90 years ago this month. It was on August 27, 1859, that Colonel Drake proved oil could be found by drilling holes in the ground. It has been 90 years of the greatest progress known in history, and no other single industry has contributed more to man's advancement than has petroleum.

The automobile, airplane, modern railways, mass industrial manufacturing methods, and mechanized farm equipment were all to come later because they necessarily depend upon the motive power and lubricating qualities of petroleum. These oil-dependent developments are largely responsible for the world we know today. Progress in transportation and mass production has narrowed distances and stimulated an abundant flow of goods, thereby enriching everyone. Our pattern of industrial manufacturing, residence community and retail trade has been decentralized and reshaped as a result. Hence, particularly in America, retail stores, restaurants, real estate values and thousands of other livelihoods have come to be dependent upon the maintenance of high volume transportation and production, and therefore upon an abundant supply of petroleum.

Oil also has become the most highly prized of all commodities used in modern warfare. Besides powering all forms of mobile units, oil is the basic ingredient used in manufacturing almost everything from the explosives in shells and bombs to synthetic rubber tires and plastic materials of all kinds.

If the oil industry had contributed nothing to the progress of civilization but motive power and lubricants, it would have played an outstanding role. But the swiftly mounting importance of petroleum also must be measured by its many additional contributions.

• • •

PETROLEUM'S CONTRIBUTIONS to the progress of man also appear in many hidden ways not generally realized and certainly not appreciated. From the moment we arise in the morning to the instance we switch off the bedside light, our everyday home life is made easier and more comfortable by the many good things made from oil and gas. Among the household products which depend upon petroleum derivatives are such varied things as shower curtains, raincoats, many medicines, upholstery fabrics, oil cloth, linoleum, rubber tile, synthetic leather, plastic materials of all descriptions, paraffin for canning, many varieties of paints, roofing and insulating materials.

Petroleum products play a vital role in the everyday life of the housewife. Oil derivatives are used in manufacturing her nylon hose and her rayon dressing gown and lingerie. Petroleum furnishes the dyes in those colorful dresses worn by milady. Her dressing table displays petroleum plastic compacts, combs, and brushes. Cold cream, hair-setting lotions, lipsticks, perfumes, nail polishes and polish removers all contain essential petroleum derivatives. Breakfast food would be soggy without its airtight oil paper wrapping. Ants would invade the jelly jar were it not sealed with paraffin or a synthetic rubber band. The wife couldn't lift the modern coffee pot or turn on the modern stove without their plastic handles, and without a petroleum-derived detergent soap she would find it more difficult to wash the dishes.

Don't think for a minute that the man of the house doesn't use many things made from petroleum also. Without oil, man would not have his brushless shaving cream, rubbing alcohol, face lotion or hair tonic. The printing ink used by the morning paper has a carbon black base made from gas. Modern radio cabinets and tuning knobs are made from petroleum plastics, and oil furnishes the waterproofing in his raincoat. Without oil, there would be no need to look in the bathroom medicine cabinet for a nose spray to relieve that cold. Nine chances out of ten, the spray used will have an oil base. The telephone instrument used to call the doctor when the cold becomes severe also is made of a petroleum plastic.

Flies and mosquitoes might arrive in swarms, but without its oil base there would be no DDT or other household and garden insecticides. While speaking of gardens, remember that petroleum also is converted in the inexpensive nitrogen fertilizers now used so widely. Oil even plays a part in fishing and golfing activities. Fishing lines and flies are made of plastics; the golf ball of synthetic rubber.

• • •

NINETY YEARS AGO no one could possibly have foreseen the far-reaching influence this then new infant business was to have on the lives of mankind. In fact, few people—all too few—even today appreciate the many great benefits derived from petroleum.

Given a fair chance, the petroleum industry will accomplish as much in the future as in the past.

Warren L. Baker

REPORT FROM
THE OBSERVATORY

Recent Favorable Economic Trends

By **RAY L. DUDLEY**, Publisher, and **WARREN L. BAKER**, Editor

BRIGHTER PROSPECTS than at any time since the beginning of 1949 were reflected by the petroleum industry's economic position at the end of July. The improved outlook resulted from favorable developments in the oil supply-demand picture during the past month, and from indications that trends in August will be equally encouraging.

Consequently, it was indicated that August may mark the turning point in the industry's economic trends, with operating rates to be upward thereafter in direct contrast with the consistent downward course of the preceding seven months of the year. Crude production and refinery runs apparently have reached their low point, and both now are likely to begin climbing.

Improvement all along the various petroleum fronts was shown by the industry's present economic position and outlook. Of foremost significance was the occurrence in July of sizeable reductions in crude stocks (as predicted in these columns last month), and indications that additional drafts will occur in August. Simultaneously, gasoline storage continued to decrease by substantial amounts, and was due to be reduced further in the next six weeks. Meanwhile, a more optimistic outlook developed for both distillate and residual fuel oils. While current stocks of distillate fuels remained quite high, much larger gains in heating oil consumption were being forecast for the coming winter than heretofore predicted. Abetted by the existence of greatly reduced prices, residual fuel oil sales also showed signs of increasing, and contrary to earlier views, stocks of this product were not considered excessive except in California.

• • •

DRAFTS ON CRUDE STOCKS attained sizeable proportions during July, a definite turn for the better. Latest available figures showed U. S. crude in storage totaled 272 million barrels on July 16, a decline of 3 million barrels (62,000 barrels daily) since May 28 and a decrease of 2 million barrels (155,000 barrels daily) in the two weeks since July 2. This constituted a marked and highly reassuring change from the steady rise in stocks for a year preceding last June.

Prospects were for additional reductions in stocks during August. Crude production may be slightly greater than in July, but anticipated higher demand and over-all improvements in the industry's general prospects presaged that refinery runs were likely to advance sufficiently to more than offset the relatively small gain expected in producing rates.

It appeared possible that withdrawals in August might reduce crude stocks to somewhere near the 260 million barrels generally considered by the industry as being adequate. At some estimates of August withdrawal rates, crude stocks the end of August would be from 263 to 268 million barrels. Either level would represent a material improvement over the 275 million barrels on hand the end of May.

• • •

FIRMER CRUDE PRICES, at least for the next two months, appeared likely as a result of the change in the crude oil picture. Prices beyond September will depend upon supply-demand relationship after the end of the gasoline consuming season.

There was evidence that recent drafts on crude stocks already had brought some tightening in the crude market. Several companies which were trying to sell some crude a month ago, no longer were anxious to dispose of their supplies. The stronger tone of crude oil markets was further demonstrated when an early July reduction of 10 cents per barrel in Texas Gulf Coast cold test and some South Texas low gravity crudes did not spread to other grades, or hardly caused comment in petroleum circles. These reductions actually constituted an adjustment, since the affected crudes had been advanced 60 cents per barrel when the general crude market advanced 50 cents in November, 1946. However, a month or more ago these price cuts would have been regarded with much anxiety. An additional development of reassuring nature, particularly to producers of heavy crudes, was the 15-cent per barrel boost given Gulf Coast heavy fuel oil prices.

• • •

IMPROVED RESIDUAL FUEL oil outlook was an outstanding highlight of trends in recent weeks. The feeling was developing that present stocks of heavy fuel were not excessive outside of California, and might actually prove to be small this winter.

Although U. S. Stocks of residual fuels were 19 million barrels above a year ago in totaling 67½ million barrels on July 16, this represented an improvement over their position at the end of March, when they were 24 million barrels larger than at the corresponding date in 1948. Of much importance was the existence of more than half of these stocks in

Greatly Improve Industry's Outlook

WORLD OIL'S summary of the oil situation at the close of July

California, and that outside of the West Coast they were only slightly above year ago levels. East of California, residual stocks amounted to 31¼ million barrels on July 16, an increase of but 3¼ million barrels over year ago levels.

Indicative of a turning point in heavy fuels was a 15-cent per barrel price increase in the Gulf Coast area on July 19, the first upward curve since a series of price reductions began last December. It was reported that one buyer seeking to purchase a large quantity of heavy fuel oil was able to find only 68 cargoes available on the Gulf Coast.

Eugene Holman, president of Standard Oil Company (N. J.), told the House Small Business Committee's oil investigators that his company was finding it necessary to increase U. S. imports of residual fuel oil. Howard W. Page, assistant to Holman, told the committee that declining residual yields from U. S. refineries made it "necessary to import increased amounts of residual to balance customers' requirements." Page reported that Jersey's imports of residual fuel oils averaged 125,000 barrels daily in June, 127,000 barrels in July, and would climb to 136,000 barrels daily in August as compared with a 1948 average of 92,400 barrels per day.

The same views with respect to residual fuel imports were expressed to the committee by John A. Walstrom, vice president of Asiatic Petroleum Corporation, who stated his company's sales to Eastern Seaboard importers had averaged about 47,000 barrels per day so far this year but may reach 75,000 barrels daily next year.

• • •

PROSPECTS FOR DISTILLATE fuel oil demand during the winter continued to improve. Sharply increased sales of fuel oil burners indicated 550,000 of these units were likely to be sold during 1949 as compared with 375,000 barrels in 1948. This growth in fuel oil burner installations, coupled with the anticipation that another warm winter in the big consuming northeast sector of the country was unlikely to follow on the heels of last year's unusually mild winter, was causing forecasts for heating oil consumption to be raised by substantial volumes. Some were predicting heating oil demand, with only normally cold weather, might be as much as 20 percent greater than in the 1948-1949 winter. Sales of distillate fuel oil to railroads, as new diesel trains go into operation, also were increasing sharply and were due to continue expanding.

Improving prospects for greatly increased sales resulted in a feeling that distillate fuel oil stocks may not be as excessive as regarded heretofore despite their current high level. These stocks throughout the nation totaled 68½ million barrels on July 16. Distillate fuel in storage east of California amounted to 57¾ million barrels on July 16, a gain of 17 million barrels or 40 percent over a year ago. However, recent weeks had seen some improvement, for east of California distillate stocks in mid-June had been 20 million barrels greater than at the corresponding period in 1948. If refiners continued to hold down production of distillate, improved relationship of these stocks with 1948 levels may be seen during the next two months. This appeared entirely possible, since quite large additions were made to storage in August and September of 1948.

An important influence on the heating oil picture has been the continued holding off of purchases by distributors and dealers. This has been a very influential factor in building up stocks at refineries and bulk terminals, which are the inventories reported by the industry. Last winter the situation was different. Distributors, dealers and even home owners stockpiled all the heating oil they could. Consequently, comparison of present distillate fuel stocks with those of a year ago does not reflect a true picture. Now that price discounts and guarantees against possible future price declines are being widely offered, heating oils were expected to begin moving into the hands of distributors and dealers in large quantities. Should the movement reach sizeable volumes, as it must sometime before winter sets in, it could easily result in a marked change for the better in the distillate fuel stock situation.

• • •

WITH IMPROVED CONDITIONS recently achieved in every phase and the outlook good for a continuation of favorable trends during the next month or two, the petroleum industry's prospects at the end of July were more encouraging than any time since the first of the year. Much will depend upon winter consumption levels, but if demand for distillate and residual fuels reaches the greatly enlarged volumes now being predicted clearer sailing lies ahead.

A RIG SIDE CHAT

about Baker Retainer Production Packers

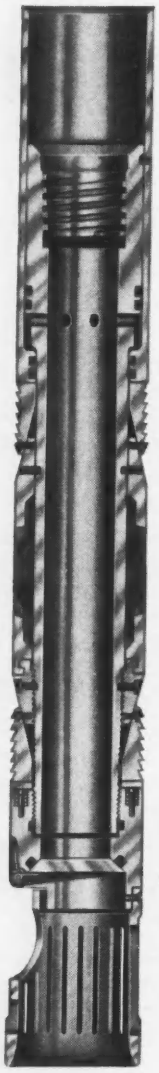
What we want to talk about today is how the Baker Production Packer is set securely in the casing, anchored against either upward or downward movement, with the tubing production string left free from the packer. The tubing is run through the body of the packer for production, and is free to be pulled at any time without disturbing the packer. In the typical application drawing (far right) the packer has been set and anchored to the casing by the two sets of opposing slips, with the Hycar packing unit sealed-off against the casing and retained in position by lead seals.

We want to produce from a zone below the packer so we make up the string with a Baker Perforated Production Tube on bottom (with operator's tubing to provide an additional stinger, if desired); above is a Baker Multi-V Tubing Seal Nipple; next a No Left Turn Latching Sub; and above that comes the tubing. Now we run-in the well until the Latching Sub engages in the top of the packer. The engaged Sub automatically positions the Multi-V Tubing Seal Nipple accurately in the smooth bore of the packer, and with 5 Hycar rings facing up and 5 more facing down, a perfect seal is obtained between the tubing string and the packer bore. Meanwhile, the Perforated Production Tube, as it was run through the bore of the packer, has unseated the Flapper Valve and now holds it in open position.

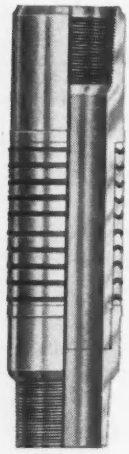
It's as simple as that, and we are ready to produce through the ⅜-inch holes in the Perforated Production Tube. These holes prevent junk, debris and large pieces of shale from entering and clogging the production string; and the total area of all holes is equal to or greater than the area of the tubing string.

When the tubing string is pulled at some future time, the Flapper Valve in the lower end of the packer body snaps back into the closed position and maintains a fluid-tight seal against upward pressure from below. The packer is not disturbed by pulling the tubing string, but remains packed-off against the casing ready for future operations.

This is only one of the many applications of the Baker Retainer Production Packer for single-zone or multiple-zone production; for selective testing and acidizing; for protection of casing from pressure or from destructive fluids, or gases; and other profitable uses.

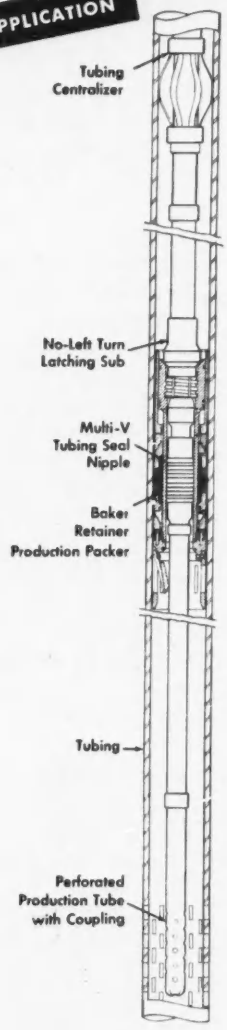


Baker Model "D" Retainer Production Packer Product No. 415-D



BAKER TUBING SEAL NIPPLE, MULTI-V TYPE, which effects a fluid-tight seal between the tubing string and the bore of the Packer.

TYPICAL APPLICATION



Single zone hook-up with production string anchored to packer, for: (a) keeping production string in tension to eliminate "tubing breathing" during the pumping cycle; (b) producing by flowing, without imposing excessive weight on packer to hold Tubing Seal Nipple positioned in packer bore; (c) making high pressure injection of gas or fluid for re-pressuring or secondary recovery.

Production string is run-in until No Left Turn Latching Sub rests on top of packer, indicated by drop in weight on strain gauge or weight indicator. The production string is then raised about 5 feet, and the zone washed and brought in, if it will flow.

If you would like to continue this rig-side chat at any well where you have a production packer problem, call the nearest Baker "Service Engineer." He will have helpful suggestions, and he is as near as your telephone . . .

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BAKER

RETAINER PRODUCTION PACKER

PRODUCT NO. 415-D

The Changing Panorama

Positive Action Urged For Meeting Recession

POSITIVE ACTION by business, government, and labor will help develop confidence and mitigate the business recession, declared Herman W. Steinkraus, president of the Chamber of Commerce of the U. S., in a radio talk.

As its part, he suggested that business should: (1) Reduce prices as fast as possible, thereby stimulating buying; (2) avoid too much retrenchment in reduction of organizations or investment; (3) launch new products; (4) strengthen sales and advertising; and (5) retain good relations with employes and unions, keeping them well informed.

Steinkraus suggested that labor should avoid demands for a fourth round of wage increases, pump priming, or increased government burden of social security on taxpayers, and should improve plans to cushion the shock, avoiding rigid adherence to wartime rules that cause hardship on individuals or management.

Government, he said, should encourage economy, avoid tax increase, encourage risk-taking, allow special quick depreciation schedules, and encourage cooperation between government, business, and labor at all levels.

Strong Factors Are in Situation of Industry

WHILE THE industry has been going through a protracted period of adjustment of operations and prices, it has had the very important advantage of continuing good demand for its principal products. This advantage, supplemented by effective action in trimming supply to fit demand, explains the resistance of crude oil and gasoline prices to deflationary forces.

Furthermore, crude prices were in an exceptionally strong position when the general business decline set in and therefore were due to hold up exceptionally well. This refers to the fact that two major companies and some independents for nearly three months last fall were paying prices 35 cents a barrel higher than the peak postings of the rest of the industry, and it appeared for a time that those increases might be generally accepted. For producers who were selling last fall to those purchasers, including Phillips Petroleum Company and Sinclair Oil Corporation, there has been actually a 35 cent cut in crude prices. Other producers may be regarded as having had a cut of about 35 cents from the standpoint that they failed to get the 35 cent raise that some producers actually got.

Trends of demand for principal refined products have continued to look favorable. Among the recent estimates of demand were those offered by Rexford S. Blazer, president of Allied Oil Company, before the National Association of Purchasing Agents at Chicago in late June. Based on usage by the different classes of consumers, he estimated that gasoline demand in 1949 would be 5 percent greater than in 1948 and that there would be increases of 9 percent for kerosine and about 10 percent for all classes of distillates. Passenger cars will largely provide the gain in gasoline consumption, he said, as truck usage will be down because of decline in business activity, while no material change from 1948 is expected for agricultural demand, tractor consumption, aircraft requirements, and industrial demand.

The gain in kerosine demand will reflect increased use by space heaters, according to Blazer, with no material change in use for jet fuel, lamps, brooders and tractors.

Distillates of the home heating oil classification will be used in larger volume because of increased oil furnace installations, Blazer said, and a normal winter may occur instead of the exceptionally mild one of 1948-1949.

Residual fuel oil is an industry by-product, Blazer emphasized, and will find markets by going at prices competitive with other fuels. He mentioned several factors that may work against a large surplus of residual fuels. Refiners are cutting yields of residual. Old refining units with high residual yields are being shut down. Refiners are minimizing use of high residual-bearing crudes. Many refiners are installing coking facilities to avoid excessive residual fuel stocks. Lower residual prices will stimulate sale as bunker oil for ships and encourage conversions to oil from other fuels by industry, such conversions having involved already 40 million barrels per year on the Atlantic seaboard alone. Lower residual prices also are expected to discourage imports and encourage exports. All these corrective factors will help, said Blazer, to stabilize the prices of residual, although prices will continue to reflect residual's true nature as a by-product.

Industry to Continue Capital Expenditures

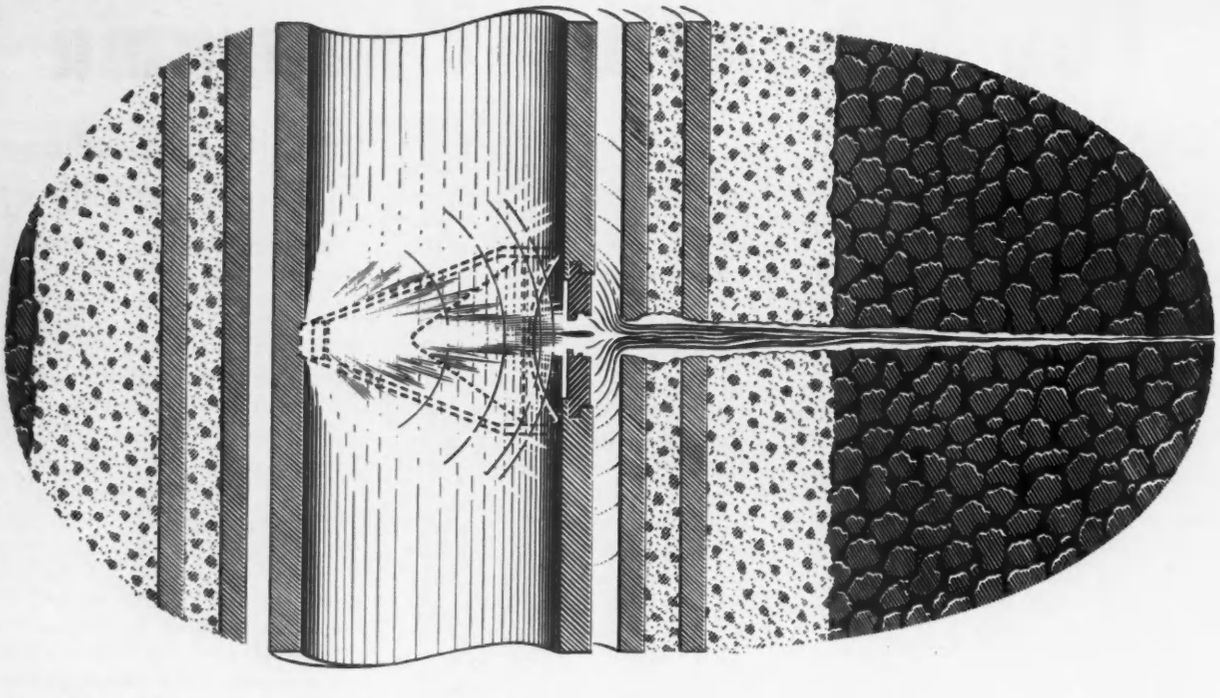
ALTHOUGH THE petroleum industry is spending slightly less in 1949 than in 1948 for expansion and improvement of facilities, it may be expected to continue making large capital investments, thereby materially helping to sustain U. S. employment and business activity.

Production and transportation capacities are at present comfortably above immediate requirements. But the reserve capacities are smaller than they were before the war and are not great enough for insurance against national emergencies. There are some misgivings even regarding adequate supplies of heating oils for all consumers next winter. The industry can supply all requirements, but in order to do so, it needs better cooperation from resellers and consumers, who should be purchasing and storing heating oils in larger volumes during the summer to be sure of adequate supplies next winter.

While the cooperation of consumers is sought, the industry may be forced to the conclusion that the surest way to prevent such winter shortages is to expand and improve its own facilities for delivering supplies where and when they are wanted. This situation may demand more tankers and barges, more storage tanks, improved terminals, new products pipe lines, and other facilities.

Crude oil production has been reduced about 800,000 barrels a day from the peak of late 1948, indicating that much reserve producing ability. But some of that will have to be used later this year, it is indicated, and a further increase in producing capacity appears essential.

Refining capacity also is sufficient for immediate overall requirements. But as in the case of crude production, it will have to continue to increase as petroleum consumption keeps on growing. Futhermore, even at present there is urgent need for new refining facilities of certain types. Especially essential are additional facilities for maximizing yields of lighter products and minimizing yields of residual fuel oil from crude. This need has been emphasized by the surpluses of heavy crude and residual fuel oil this year. It is particularly acute in California, where consumption trends show that residual will continue in oversupply until produced at refineries in lower yields. California refiners have projects under way to solve the problem and the work will require several years.



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Monthly News Analysis

BUYING DELAY MAY CAUSE TROUBLE . . . UNSETTLED MARKETS CONTINUE
U. S. OIL INVESTMENTS TOTAL $21.7 MILLION . . . GAS STANDARD SET

Delay in Buying May Cause Shortages of Heating Oils

Spot shortages of heating oils are threatened for next fall and winter because these oils have not been moving in sufficient volume from refineries and terminals to the storage tanks of resellers and consumers. Several industry economists have pointed out recently that the so-called present period of "oil abundance" has a large artificial element of excess supply in it because of currently deferred buying by resellers and consumers.

What is popularly referred to as the "buyers' strike" and which in reality is a postponement of filling secondary and tertiary storage with winter requirements of kerosine, distillates and residual fuel oil, has resulted in fuel oil demand dropping about 25 percent off buying levels of last year. The fact that total oil demand is off about 5 percent from 1948 levels is accounted for chiefly by the decrease in demand for heating oils which outweighs the current record increased demand for gasoline. As a result primary storage has been building up rapidly.

It is estimated that deferred purchase of winter petroleum products during the second quarter of 1949 has totalled 440,000 barrels a day, even on the basis that 1949-1950 winter consumption will show no increase over that of 1948-1949. During the last several years the annual rate of increase has been about 5 percent, and many industry economists believe consumption next winter will run at least 2 percent over that of last. On that basis, buying for the second quarter of this year would represent a deficit of about 600,000 barrels daily in terms of forthcoming requirements.

Production of winter products for the second quarter of 1949 totalled 207 million barrels as against 210 million for the corresponding period last year, and the rate of stocks accumulation was about 20 percent less than in 1948.

Normal reselling demand (secondary storage) for the last three months of 1949 and the first three months of 1950 is estimated at about 6½ million barrels daily, exclusive of stepup due to deferred purchases, or about 6,700,000 barrels daily when compensation is allowed.

However, an abnormally cold winter could boost total oil demand over 7 million barrels a day, a situation that would require increasing domestic production by 500,000 barrels daily over current levels.

Discounts Are Offered on Oil Purchases in Summer

Major companies that supply heating oils for consumption in the East Coast region and the Middle West are putting forth special efforts to stimulate movement of oils from refineries to resellers and consumers. Such movements have been subnormal because of assumptions that supplies would be adequate and that prices might go lower. The companies see an urgent need for increased movements into tanks of consumers so as to help assure ample supplies throughout the cold weather next fall and winter.

To encourage early filling of furnace oil and kerosine storage tanks, the large companies are offering special discounts to resellers and householders, besides assuring them that they would also be given the full advantage of any price reductions that might occur prior to October 1. A discount of one-half cent per gallon has been offered to consumers by various East Coast companies on July and August deliveries of heating oil and kerosine and also will be made on deliveries accepted in June.

Filling of storage tanks by resellers and consumers during the summer months will make additional storage capacity available at refineries and oil terminals, it is pointed out, and thus increase overall stocks and assure ample supplies for all consumers.

Resellers buying at the tank car and barge level are offered a discount of six-tenths cent per gallon on July deliveries of heating oil and kerosine and one-half cent on August deliveries and also will receive the benefit of any price decline which may occur prior to October 1.

One company in offering the discounts predicted that demand for kerosine and heating oil along the East Coast for the 1949-1950 heating season may exceed last season by 20 percent, based on the region's experiencing a normal winter. Such a demand cannot be met from production alone next winter, it stated, but a large part of the supplies must come from inventories built up this summer and early fall. Even if every tank is filled by fall, said the statement, it will still be necessary for the oil industry to manufacture home heating oil and kerosine during the winter at a greater rate than is now being done or has ever been done before.

Only if consumers and resellers fill their tanks early and keep them filled can the most use be made of refining and transportation facilities during the summer, the company pointed out.

Another East Coast major company stated during the first half of July that the current movement of heating oil and kerosine into secondary and consumer storage tanks was "entirely inadequate to meet the potential situations which may occur in the event of an early fall due to storms or otherwise, or emergency closing of refineries at the start of the heating season."

In the Middle West prices of heating oils were reduced one-half cent a gallon in June, and consumers have been urged to take advantage of the lowered prices. It is pointed out that it is not known how long the reduced prices will remain in effect. At the same time, the consumers are protected against any price declines and will be billed for summer purchases at the lowest prices that may prevail prior to September 1. An added advantage of summer filling is that it guards against the hazards of moisture condensing in empty storage tanks, one major company pointed out in newspaper and radio advertising. In the case of underground tanks, it stated, they are anchored firmly by being filled.

Price Declines Occur in Unsettled Oil Markets

Markets for crude oil and refined products have continued unsettled, and July has brought additional lowering of crude and product prices, although the price reductions have been less common than in earlier months.

Effective July 8, Humble Oil & Re-

fining Company reduced by 10 cents per barrel its posted prices for low cold test crudes produced on the Texas Gulf Coast and for low gravity Mirando grade crude. Other purchasers subsequently met the reductions on these crudes. Humble explained that the adjustment eliminated a differential in favor of these grades that was applied in November, 1946, when special demand for them existed, as that special demand no longer prevails.

The Pure Oil Company, effective July 1, lowered its Michigan crude price postings an average of 11 cents per barrel. The revisions put Pure's postings closely in line with those of other purchasing companies, which previously had reduced prices.

Owensboro-Ashland Company effective July 1 reduced postings in two Western Kentucky fields, cutting Butler County 22 cents a barrel and Bowling Green area 15 cents.

Continued instability of prices for heavy crudes in California is indicated. Standard Oil Company of California has been canceling crude purchase contracts having three months or six months cancellation clauses at end of such periods and has been substituting 24 hour cancellation clauses in new contracts. The company has stated that production of heavy crude has been running 100,000 barrels per day above demand, despite three reductions in prices in 1949. Under the new contracts the company is expected to apply pipe line proration of purchases, gradually reducing takings, in absence of state proration in California.

There has also been some speculation that pipe line proration may be applied by purchasers of West Texas crude because supplies have been taxing their storage facilities. Although Texas production allowables have been sharply reduced in 1949, some grades, including West Texas sour crudes, have remained in oversupply, while some sweet crudes have been relatively scarce.

Markets for fuel oils have continued unsteady, with stocks at refineries and terminals large and movement to secondary storage subnormal because of the possibility of further price declines. Major companies are offering discounts of around one-half cent per gallon on July and August purchases of heating oil and kerosine by resellers and consumers. While this is an effort to stimulate movement to consumers' storage tanks for use next winter, it represents nevertheless a further lowering of prices to be received by the refiners for these oils.

In the Mid-Continent there occurred before the middle of July some slipping of refinery prices of third grade gasoline and both light and heavy fuel oils. Although gasoline demand has been generally good, it has not been so heavy as expected in some districts, and spot shortages of gasoline, which previously appeared a possibility, now seem less likely to occur. In Central Michigan, meanwhile, there was also some weakening of wholesale prices of gasoline, heating oil, and heavy fuel oil. On the Gulf Coast and the East Coast prices of refined products were generally steady through the middle of July. Prices of crude and products also appeared firm in Western Pennsylvania.

California Disturbed Less By Surplus of Heavy Fuels

While the problem of over-production and increasing stocks of heavy fuel oils and heavy crudes in California still is serious, indications are that the demand for fuel oil no longer is declining at the same rapid rate that it was earlier this year, according to a recent report, "Review of California Oil Industry Conditions," compiled and recently released by Oil Producers Agency of California. In the report, which thoroughly reviews the supply-demand picture by products over the past ten years, the Agency suggests that the effect of recent shutting-in of over 55,400 barrels per day of heavy oil production in some two dozen California fields should begin to make itself felt in product yields from the refineries, and any future decrease in total production, regardless of gravity, would be reflected in a decreased supply of residual fuel, since all oil contains some residual fuel.

In explaining the reasons for their belief that the downward trend in demand for heavy fuel oil may have been slowed, the Agency cites the case of three large public utility companies that have estimated they will use some 15 million barrels more fuel oil in 1949 than they did in 1948. It is believed, also, that other large industrial users may be expected to follow suit in view of the present cost relationships between natural gas and fuel oil.

There is no escaping the fact, however, that at present more fuel oil is available than the market can absorb. Although stocks of fuel oil have been, and still are increasing, the Agency feels that stocks are not yet high in relation to former stock levels nor in relation to current demand.

With demand for gasoline, gas-oil and diesel oil still on the increase, and with stocks of these products at generally lower than normal levels, it has become apparent that a partial solution, at least, to the over-all problem lies in the developing of improved refining process that will yield less residual oil and more of the lighter products from a barrel of crude. The agency points out that refiners have recognized the problem and are formulating plans for the construction of plants that will considerably increase the yield of lighter products. Underscoring the possibilities of these new types of processes is the recent announcement by one major company that most of its technological problems in its new process are well on the way to being solved, and further that the expected yield of light products from available crude may be increased by more than 50 percent. While no schedules of plant construction have been announced by the major companies, it is expected that it will require from two to three years to design, construct and put into operation plants which can be expected to alter the refinery yield sufficiently to alleviate the present condition of over-supply of heavy fuel.

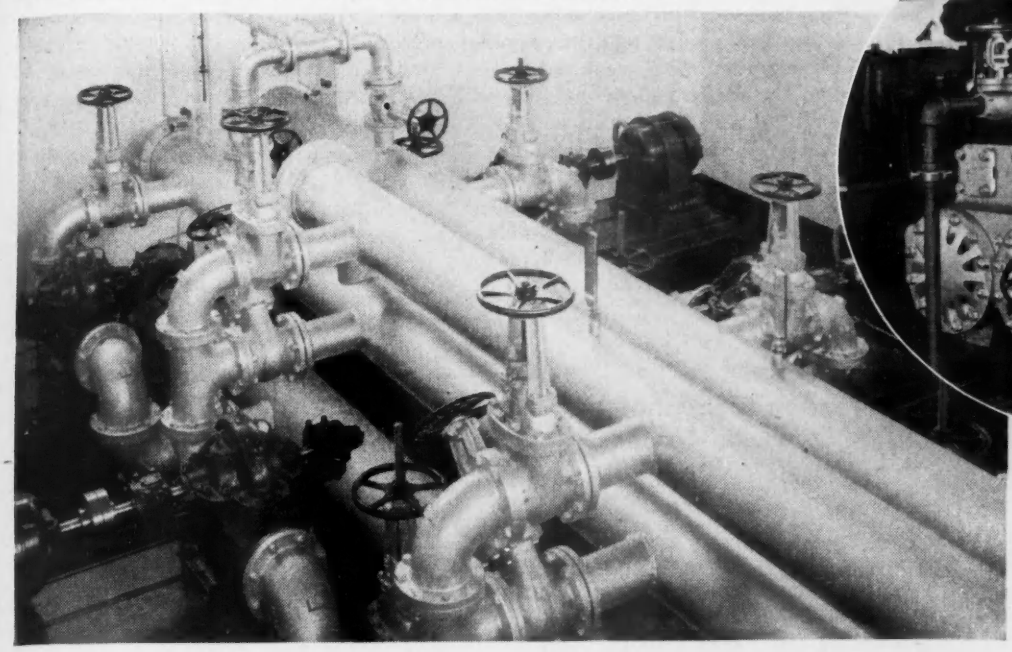
$21.7 Million Invested in U. S. Petroleum Industry

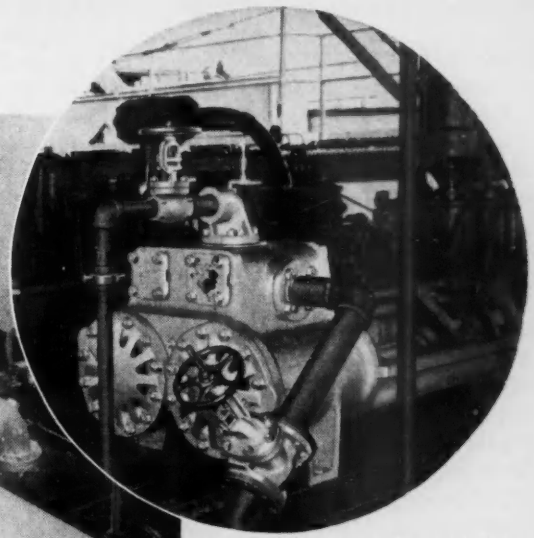
Gross investment in property, plant, and equipment of the petroleum industry of the U. S. was increased by $2.1 billion in 1948 and amounted to $21.7 billion at the end of the year. This estimate is for the entire industry, although it is included in the report, "Financial Analysis of 30 Oil Companies for 1948," by Dr. Joseph E. Pogue, vice president of the Chase National Bank, and Frederick G. Coqueron, staff associate in the bank's petroleum department. The 30 companies analyzed comprise nearly two-thirds of the petroleum industry in the U. S.

Production department facilities account for a little over one half of the $21.7 billion gross investment in the domestic industry. The total includes $11,525 million or 53.1 percent in the production department; $4,150 million or 19.1 percent in the refining department; $3,125 million or 14.4 percent in the transportation department; $2,600 million or 12.0 percent in the marketing department; and $300 million or 1.4 percent in other facilities. As compared with one year previously or the end of 1947, the $21.7 billion total gross investment for the industry was up $2.1 billion, and increases by departments included $1.1 billion in production facilities; $550 million in refining; $275 million in transportation; $125 million in marketing; and $50 million in other facilities.

The 30 companies studied in the report invested $2,591 million in property, plant, and equipment in domestic and foreign operations in 1948, bringing their gross investment up to $16,819,736,000 at the end of the year. This total included $14,888,966,000 in the

PUMP HOUSE *in booster station, showing Crane gate valves and flanged fittings.*





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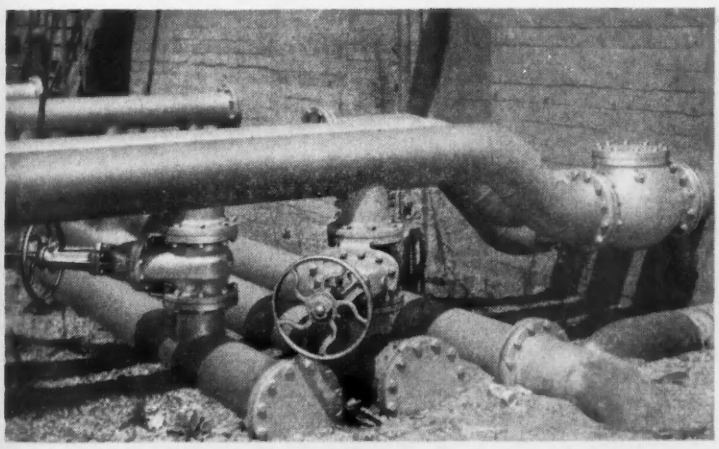

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The $14,888,966,000 domestic gross investment of the 30 companies included $7,461,662,000 or 50.1 percent in the production department, of which $7,351,958,000 represented leases, wells, equipment, and natural gasoline plants and $109,704,000 was in natural gas facilities. The transportation facilities of $1,989,628,000 or 13.4 percent of the total domestic investment of the 30 companies included $1,156,329,000 in crude oil pipe lines, $204,481,000 in product pipe lines, $560,879,000 in marine facilities, $34,429,000 in tank cars, and $33,510,000 in motor transport. Refining department gross investment of $3,303,611,000 was 22.2 percent of the total, marketing of $1,872,181,000 was 12.6 percent; and other facilities of $261,884,000 were 1.7 percent of the total.

The 30 companies in 1948 made expenditures of $1,329 million for developing crude production in the U. S. Of this total, $1,120 million went for acquisition of new and renewal leases and cost of drilling and equipping wells, including dry holes; $156 million was exploratory expense, including land, geological, and geophysical activities; and $53 million was for lease rentals. Compared with the $1,329 million spent in developing crude production, the 30 companies had net crude production of 1,093 million barrels for the year. This indicated expenditures of $1.22 per barrel of production, compared with $1.01 per barrel in 1947 and 85 cents per barrel in 1946. Thus for 1948 the expenditures per barrel for developing crude production in the U. S. were up 20.8 percent over 1947 and 43.5 percent over 1946.

Texas Sets Up Standard For Measurement of Gas

Under the gas measurement bill signed into law in Texas, all gas sold will be measured at a standard pressure base of 14.65 pounds per square inch and at a 60° F. temperature. It is believed this standard may be recognized also in other oil and gas producing states and become the accepted standard over the nation. The legislation is intended to standardize measurement practices to assure producers and royalty owners payment for true volume of gas sold and to assure the state proper tax revenue from this source.

The bill included an amendment providing that "when provisions of the act operate to change the basis for measurement in existing contracts, then the price for gas, including royalty gas, provided for in such contracts shall, if either the purchaser or seller so desires, be adjusted to compensate for the change in the method of measuring the volume of gas delivered thereunder. This provision is intended to protect parties to contracts now in existence, so that after this act becomes effective the total amount of money paid for a volume of gas purchased, or required to be accounted for, under existing contracts shall remain unaffected by this act."

The act also provides that the Texas Railroad Commission is to determine the average temperatures and other factors of gas in all the oil and gas fields of the state. It provides a defense against penalty for violating the act if the commission has not published its findings on the field in question.

Protection Is Sought for U. S. Oil Firms Abroad

Oil industry legal experts are considering to what extent President Truman's "Point Four" program can be the means for breaking growing nationalistic barriers around the world against the operations of the American petroleum industry abroad. The President recently sent his "Point Four" plan to Congress, supplementing the three other points in his overseas policy as contained in the inaugural address of last January 20. "Point Four," as defined by Truman, calls for increasing world trade and elevating living standards by sending technical assistance and private capital from the developed to the underdeveloped areas of the world.

The extent and cost of guarantees that the Export-Import Bank will give private capital to encourage its investment in oil areas in the Middle East and South America hinge on the amount and kind of risks involved. Truman has asked the bank to insure investors against "risk of loss through expropriation without compensation, unfair or discriminatory treatment, destruction through war or rebellion, or the inability to convert their earnings into dollars." The State department has begun negotiation on a series of "investment treaties" designed to afford such protection. This diplomatic means is seen by industry officials as the way the oil industry can at last be protected from the rising tide of national controls in practically every oil-producing nation of the world today.

The Export-Import Bank plans to charge insurance rates based on the kind of protection asked and the nature of the project involved. The bank has $900 million remaining and uncommitted of its $3500 million.

Initial inquiries of prospective investors stress the fact that the most important encouragement needed is the creation of conditions and an atmosphere in foreign countries that will invite, not scare off, extension of the oil industry in those areas most in need of development at this time. Truman himself emphasized that "In negotiating these treaties we do not, of course, ask privileges for American capital greater than those granted to other investors in underdeveloped countries or greater than we ourselves grant in this country."

Truman specified a sum of $45 million as a minimum needed for technical assistance to receiving areas. Another $1 billion may be sought from Congress shortly.

Congress Will Be Asked for Further Import Regulations

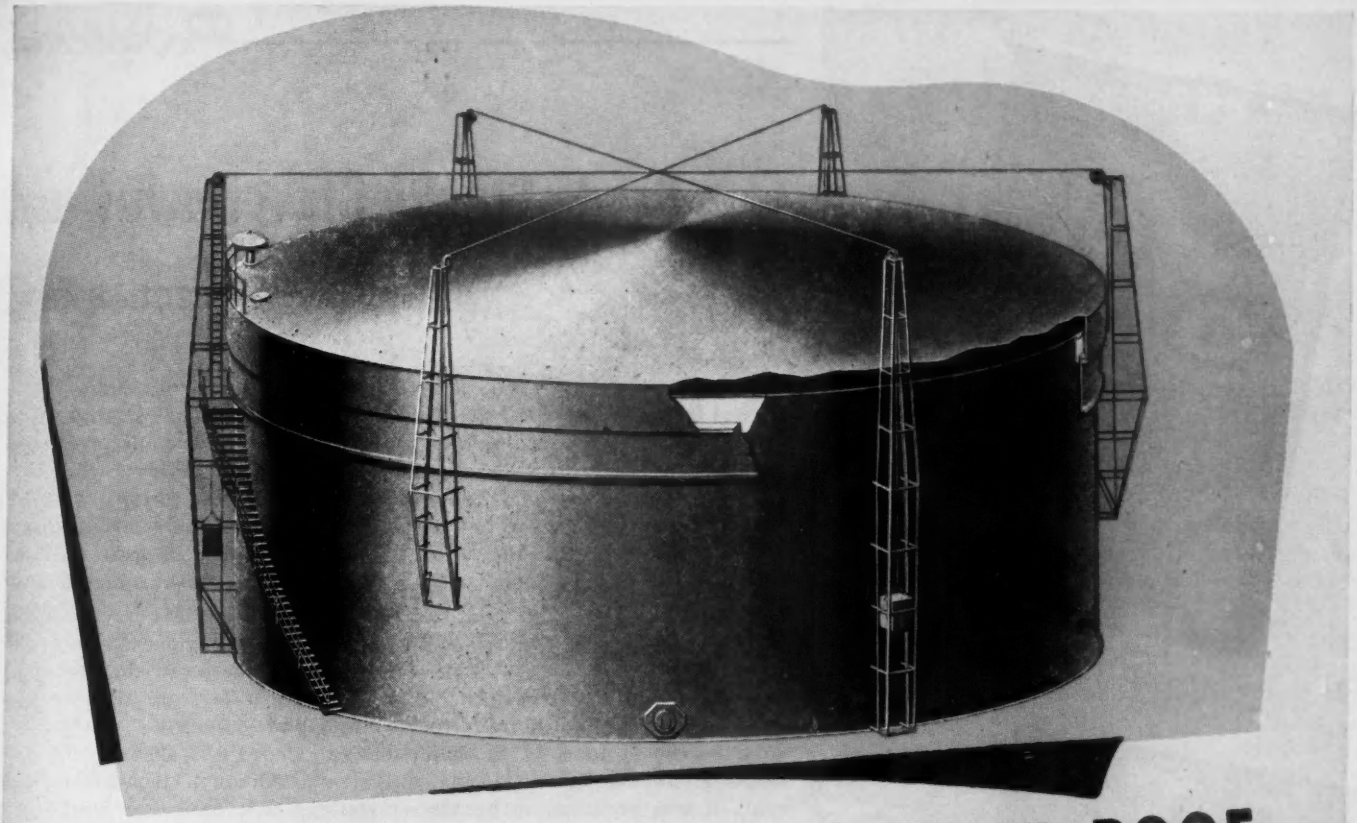
Many other industries as well as the petroleum industry are concerned over the danger of imports to domestic production. Congress therefore will be urged to consider various amendments to the Reciprocal Trade Agreements Act, under which tariff rates have been lowered and imports have been encouraged.

In the Senate three different amendments have been suggested. Senator Millikin of Colorado has proposed an amendment that would preserve the present "peril point" provision in the new law. It would authorize the Tariff Commission to make a study of the effect of imports on industries and recommend to the President such action as is necessary to protect those industries. Strong support for this amendment is claimed.

Senator George Malone of Nevada has proposed a "flexible tariff" provision. It would establish a board to study imports and provide regulations protecting domestic industries at times when imports threaten to be excessive.

Senator Thomas of Oklahoma has a specific amendment with relation to petroleum, which would provide quotas limiting imports to an amount not to exceed 5 percent of domestic requirements. This proposal has been approved in substance by the Independent Petroleum Association of America, which is vigorously fighting for restrictions on oil imports.

Of particular significance in regard to oil imports is the fact that the National Petroleum Council has been asked by Secretary of Interior Krug to make a new study of the problem. NPC previously expressed the view that imports should supplement but not supplant domestic production. But Krug requested a detailed study and recommendations for handling the problem. He also asked for recommendations as to achieving and maintaining U. S. reserve capacity for producing oil for national emergencies.



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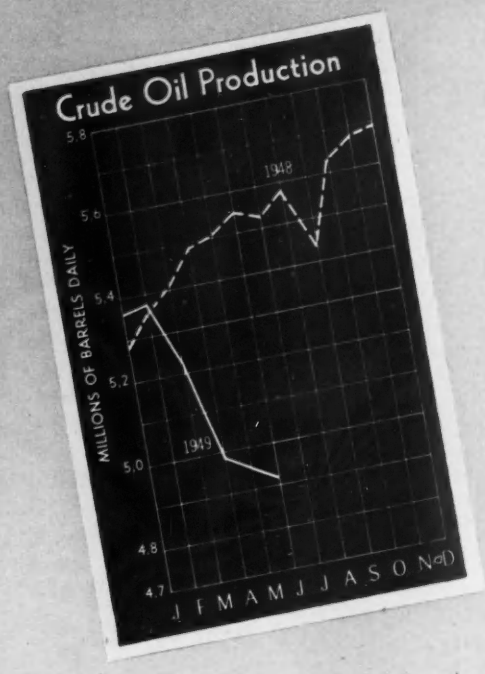
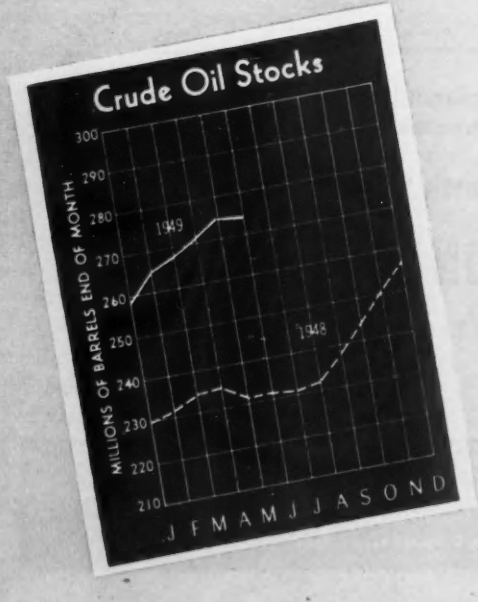




Crude Stocks Start Downward

By CECIL SMITH,

CRUDE stocks, the cause of considerable concern to the industry because of their size and tendencies to grow even larger, at last started downward during June, but it took a cutting-back of domestic crude production to the lowest level since March, 1947, to accomplish the feat.

A small decrease was made in the amount of crude processed by refineries during the month, but increased gasoline yields boosted output of this product to the highest point since December of last year and resulted in lowering fuel oil production to the lowest level since March, 1947.

Stocks of gasoline and fuel oils, like crude stocks, have been causing uneasiness because of their magnitudes, but gasoline, at least, was beginning to show improvement. Fuel oil inventories continued their seasonal climbs during June, but at a slightly reduced rate from the previous month's, a result of lowered refinery inputs and yields.

At the end of June, U. S. crude stocks totaled 274,256,000 barrels after dropping 862,000 barrels during the month. Although the decline was small, it was encouraging because it was the first time that stocks had turned downward since July of last year, and they were approaching a point that was beginning to cause some alarm. Further encouragement has come with later reports of continuation of the decline past the middle of July.

Gasoline stocks thought by many to be excessive are now being drawn upon heavily. End of June stocks totaled 114,490,000 barrels, a decrease of 5,505,000 barrels during the period. Although these stocks amounted to almost 10 million barrels more than were on hand a year earlier, the situation should not be the cause of concern because of increased demand for this product.

Demand for gasoline this year has been running almost 7 percent ahead of last year, and stocks at the end of June were less than 10 percent more than were in tanks at the same time in 1948. At the end of March, when gasoline stocks normally hit their peaks, they were almost 14 percent higher than a year earlier, showing that considerable improvement had

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1948:									
January	5,283	5,348	229,842	2,328	102,167	1,082	39,788	1,278	36,260
February	5,353	5,380	231,419	2,264	110,999	1,127	33,019	1,295	35,602
March	5,406	5,387	234,164	2,252	111,949	1,050	30,570	1,307	34,192
April	5,484	5,540	234,506	2,396	109,289	978	32,564	1,303	35,527
May	5,502	5,668	231,318	2,486	108,552	992	38,551	1,314	41,123
June	5,544	5,632	231,412	2,529	104,518	998	45,835	1,280	44,213
July	5,522	5,631	230,955	2,494	98,839	994	56,045	1,264	49,448
August	5,577	5,621	231,954	2,532	95,445	1,038	65,887	1,248	55,009
September	5,435	5,376	237,302	2,416	90,518	961	73,854	1,154	58,682
October	5,632	5,594	243,972	2,490	92,426	1,069	79,992	1,268	61,456
November	5,675	5,672	250,066	2,551	95,589	1,081	80,658	1,277	64,865
December	5,688	5,720	256,254	2,626	103,697	1,106	71,475	1,299	64,021
1949:									
January	5,365	5,641	258,648	2,538	116,621	1,063	61,584	1,348	62,508
February	5,376	5,480	265,216	2,484	126,054	1,004	53,937	1,282	59,398
March	5,224	5,352	269,341	2,470	127,443	933	48,923	1,258	58,190
April	5,012	5,141	272,520	2,494	125,351	846	51,231	1,147	59,668
May	4,954	5,257	275,118	2,562	119,995	853	57,096	1,170	63,552
June	4,924	5,236	274,256	2,591	114,490	779	64,148	1,128	65,857
June, 1949 Changes:									
In Month	—30	—21	—862	+29	—5,505	—74	+7,052	—42	+2,305
In Year	—620	—396	+42,844	+62	+9,972	—219	+18,313	—152	+21,644

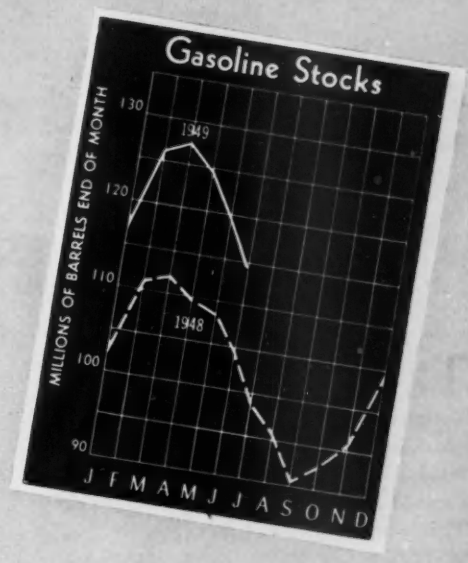
After Production Cutbacks

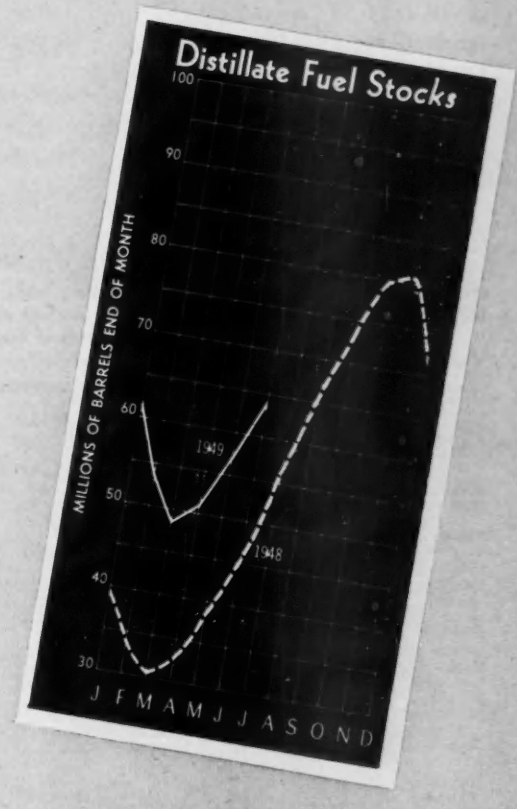
Staff Writer

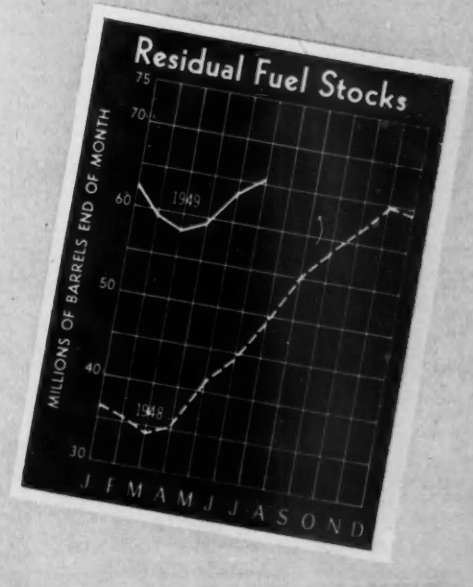
been made by the end of June when the difference had been narrowed to less than 10 percent.

U. S. crude production during June was lowered 30,000 barrels a day from the previous month's output to reach the lowest level since March, 1947. Further reductions in the nation's crude production are slated for July and August as a result of additional lowerings of allowable output made by several state agencies. This should result in additional withdrawals from crude stocks as supply and demand were fairly well in balance during June. The reductions from crude stocks amounted almost exactly to the amount of the production cutback.

The combined production of the light and heavy fuel oils in June hit the lowest mark it had since March, 1947. Distillate fuel averaged 779,000 barrels daily, a drop of 74,000 barrels a day from May's output, and residual oil dropped 42,000 daily to average 1,128,000 barrels. Additions to stocks of these products amounted to 9,357,000 barrels, while a month earlier 10,515,000 barrels had been sent to storage. Distillate at the end of June totaled 64,148,000 barrels, 18,313,000 barrels or 40 percent more than stocks a year ago. Residual totaling 65,857,000 barrels represented an increase of 21,644,000 barrels or 49 percent more than was in storage at the end of June, 1948.







State Crude Oil Production

(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL FIRST HALF YEAR		
	June, 1949	May, 1949	June, 1948	% Diff. June, '48-'49	1949	1948	% Diff. '48-'49
Alabama	1.2	1.2	1.4	— 14.3	219	231	— 5.2
Arkansas	79.7	85.1	85.6	— 6.9	15,316	15,592	— 1.8
California	922.8	938.8	948.9	— 2.8	170,171	171,174	— 0.6
Colorado	64.4	65.4	47.1	+ 36.7	11,788	8,301	+ 42.0
Florida	1.4	1.3	0.8	+ 75.0	235	142	+ 65.5
Illinois	178.6	178.9	177.9	+ 0.4	31,634	31,611	+ 0.1
Indiana	25.0	24.6	18.3	+ 36.6	4,269	2,891	+ 47.7
Kansas	282.3	290.2	313.3	— 9.9	52,465	53,992	— 2.8
Kentucky	23.7	23.8	23.7	.....	4,174	4,266	— 2.2
Louisiana	517.3	518.3	493.6	+ 4.8	93,878	87,917	+ 6.8
North Louisiana	116.0	121.2	119.2	— 2.7	21,991	21,183	+ 3.8
South Louisiana	401.3	397.1	374.4	+ 7.2	71,887	66,734	+ 7.7
Michigan	39.5	41.6	45.7	— 13.6	7,950	8,182	— 2.8
Mississippi	101.8	108.4	125.4	— 18.8	19,692	21,904	— 10.1
Missouri	0.1	0.1	0.1	.....	21	27	— 22.2
Montana	26.4	25.3	26.8	— 1.5	4,621	4,514	+ 2.4
Nebraska	0.4	0.3	0.7	— 42.9	101	118	— 14.4
New Mexico	135.9	128.8	127.7	+ 6.4	24,086	23,323	+ 3.3
New York	14.1	13.8	13.2	+ 6.8	2,295	2,306	— 0.5
Ohio	10.0	9.9	9.8	+ 2.0	1,720	1,606	+ 7.1
Oklahoma	406.8	429.1	423.8	— 4.0	76,509	74,575	+ 2.6
Pennsylvania	29.8	30.2	36.4	— 18.1	5,730	6,350	— 9.8
Tennessee	.....	.....	.....	.....	3	3	.....
Texas	1,929.0	1,913.9	2,470.9	— 21.9	380,530	441,588	— 13.8
Dist. 1—South Central	26.1	25.8	28.6	— 8.7	4,799	4,793	+ 0.1
Dist. 2—Middle Gulf	121.1	121.5	173.7	— 30.3	25,092	31,196	— 19.6
Dist. 3—Upper Gulf	370.5	373.5	497.6	— 25.5	74,669	90,083	— 17.1
Dist. 4—Lower Gulf-S.W.	188.3	187.6	256.4	— 26.6	36,918	46,378	— 20.4
Dist. 5—East Central	34.6	34.8	47.0	— 26.4	7,210	8,226	— 12.4
Dist. 6—Northeast	329.8	335.7	433.9	— 24.0	66,979	78,688	— 22.5
Dist. 7-B—North Central	59.7	56.9	48.3	+ 23.6	10,983	8,159	+ 34.6
Dist. 7-C—West Central	42.2	42.3	46.0	— 8.3	8,218	8,081	+ 1.7
Dist. 8—West	527.3	520.7	697.6	— 24.4	106,657	122,974	— 13.3
Dist. 9—North	136.6	126.1	139.9	— 2.4	23,680	25,453	— 7.0
Dist. 10—Panhandle	92.8	89.0	86.3	+ 7.5	16,161	15,680	+ 3.1
Utah	0.8	0.5	.....	.....	61	.....	.....
Virginia	0.1	0.1	0.1	.....	17	23	— 26.1
West Virginia	8.2	7.8	7.5	+ 9.3	1,367	1,319	+ 3.6
Wyoming	124.8	116.2	145.7	— 14.3	22,330	26,056	— 14.3
Total United States	4,924.1	4,953.6	5,544.4	— 11.2	931,182	988,011	— 5.8

Completions

Exceed 1948 Rate

THE first six months of this year saw a higher rate of U. S. drilling than the same half of record-breaking 1948, and results were that completed wells increased slightly more than four percent. This occurred despite drilling cutbacks in regions of lower crude prices, and crude output reductions in controlled-production states. The best example of government-imposed curtailment of production was in Texas, but despite the reductions, well completions so far this year far outnumbered those of last year's first half.

In the U. S. as a whole, 18,767 wells were completed in the first six months, while a year ago they had totaled 18,012 and that amounted to an increase of 4.2 percent. However, the gain in footage drilled in these wells more than doubled that amount. This year 67,595,274 feet have been drilled for a lead of 9.5 percent over the 61,755,171 feet penetrated in the first half of 1948. This year's new wells have averaged 3636 feet each and those of 1948 were drilled to an average of 3465 feet.

The difference in average depths was due principally to slackened drilling rates in the shallow fields of the Appalachian Region along with increased activity in deeper areas. Major drilling states where wells were drilled deeper included: California, Louisiana, Kansas, Oklahoma, and Wyoming. Texas averaged slightly less than last year's.

The number of active drilling rigs has declined substantially in past few months and reports continue to indicate increases in number of idle units. This trend will be reflected by fewer wells completed in the coming months.

Well Completions in the United States During June, 1949, and Cumulative for Year

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from The Producers Monthly)

STATE OR DISTRICT	MONTHLY COMPLETIONS, JUNE, 1949									TOTAL COMPLETIONS				CUMULATIVE TOTAL				Rigs in Operation (Drilling, Rigging Up and Shut Down)		
	NEW WELLS								Total Drilled Deeper											
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New		June, 1949	May, 1949	June, 1948	Footage June, 1949	Wells 1949	Wells 1948	Percent Diff.	Footage 1949	June 30, 1949	May 31, 1949	June 30 1948
Alabama												2		6	8	— 25.0	33,359	7	4	3
Arizona												1		3	1	+200.0	7,766	7	6	6
Arkansas	18		2	16	1			37		37	27	25	127,306	151	139	+ 8.6	616,014	27	35	49
California	197		5	56				258	5	263	220	258	1,091,242	1,355	1,275	+ 6.3	5,319,751	232	267	282
Colorado	1			3				4		4	11	20	24,116	28	124	— 77.4	118,739	20	18	52
Florida				1				1		1		2	2,928	9	12	— 25.0	57,731	3	2	7
Georgia											1			4	2	+100.0	12,437	1	1	
Illinois	131			122			1	254	1	255	235	236	601,903	1,112	1,030	+ 8.0	2,779,134	238	275	241
Indiana	39		3	62				104		104	132	85	198,359	538	465	+ 15.7	1,024,340	151	137	111
Kansas	120		45	96			1	262		262	248	332	848,153	1,364	1,409	— 3.2	4,545,649	310	314	266
Kentucky	25		23	24				72		72	72	78	137,690	420	358	+ 17.3	764,592	85	84	80
Louisiana	120	13	19	63				215		215	173	216	1,099,822	988	1,024	— 3.5	5,691,347	211	236	226
North Louisiana	72	7	18	40				137		137	97	132	400,574	524	644	— 18.6	1,744,441	58	71	73
South Louisiana	48	6	1	23				78		78	76	84	699,248	464	380	+ 22.1	3,946,906	153	165	153
Maryland															1	—100.0				
Michigan	46			35				81		81	74	65	185,283	450	311	+ 44.7	1,013,035	120	130	117
Mississippi	14	1	1	18				34		34	30	34	243,636	177	193	— 8.3	1,325,556	23	26	56
Missouri											2			7	26	— 73.1	3,096	8	5	8
Montana	4			5				9		9	22	21	26,251	97	141	— 31.2	278,445	64	51	48
Nebraska	1			1				2		2			7,109	2	1	+100.0	7,109	3	1	2
Nevada																		1	1	1
New Mexico	25		5	10				40		40	52	66	178,295	278	324	— 14.2	1,183,574	93	93	109
New York	23		1		17			41		41	53	163	60,644	567	852	— 33.5	798,634	97	109	207
North Dakota																		1	1	
Ohio	26		23	20				69	1	70	103	121	145,841	519	625	— 17.0	1,162,202	141	134	212
Oklahoma	210		21	145	1	3		380	12	392	351	333	1,349,351	2,059	1,918	+ 7.4	7,435,340	461	486	565
Pennsylvania	54		25	6	52	5		142	3	145	130	296	262,259	1,082	1,594	— 32.1	1,908,970	239	241	435
South Dakota				1				1		1			2,825	1	1		2,825	2	2	
Tennessee											5	7		14	28	— 50.0	14,376	6	6	20
Texas	787	22	48	408	6			1,271	13	1,284	1,195	984	5,088,151	6,995	5,555	+ 25.9	29,339,348	1,209	1,260	1,452
Dist. 1—South Central	21			21				42		42	45	29	140,928	288	232	+ 24.1	843,929	37	43	46
Dist. 2—Millde Gulf	28	7	5	18				58	3	61	54	56	326,229	331	384	— 13.8	1,947,139	35	45	69
Dist. 3—Upper Gulf	73	7	5	52				137	1	138	91	101	788,096	665	506	+ 31.4	4,106,218	123	137	126
Dist. 4—Lower Gulf-S.W.	47	6	7	44				104	3	107	113	128	502,506	730	673	+ 8.5	3,588,027	95	106	125
Dist. 5—E. Central	8			3				11		11	15	25	69,055	117	100	+ 17.0	561,984	16	16	42
Dist. 6—Northeast	66	2	2	10				80		80	100	34	347,299	483	183	+164.0	2,092,217	34	42	47
Dist. 7-B—N. Central	76		5	104				185	1	186	165	124	555,950	961	635	+ 51.3	2,925,585	177	159	177
Dist. 7-C—W. Central	26			8				34		34	65	44	162,549	210	185	+ 13.5	1,018,559	50	57	75
Dist. 8—West	230		2	33				265	5	270	272	233	1,244,368	1,405	1,370	+ 2.6	6,927,846	377	393	479
Dist. 9—North	139		1	113	6			259		259	171	181	648,431	1,219	1,028	+ 18.6	3,402,642	153	135	111
Dist. 10—Panhandle	73		21	2				96		96	104	29	302,740	586	259	+126.3	1,025,202	112	127	155
Utah	6			2				8		8	6	3	36,835	25	12	+108.3	116,523	15	18	9
Virginia															1	—100.0				
Washington												1			2	—100.0				
West Virginia	4		26	3				33	2	35	33	57	106,587	222	371	— 40.2	648,993	224	240	384
Wyoming	20			27				47		47	40	46	211,400	294	209	+ 40.7	1,386,389	99	94	142
Total United States	1,871	36	247	1,124	77	8	2	3,365	37	3,402	3,215	3,452	17,035,986	18,767	18,012	+ 4.2	67,595,274	4,098	4,277	5,090

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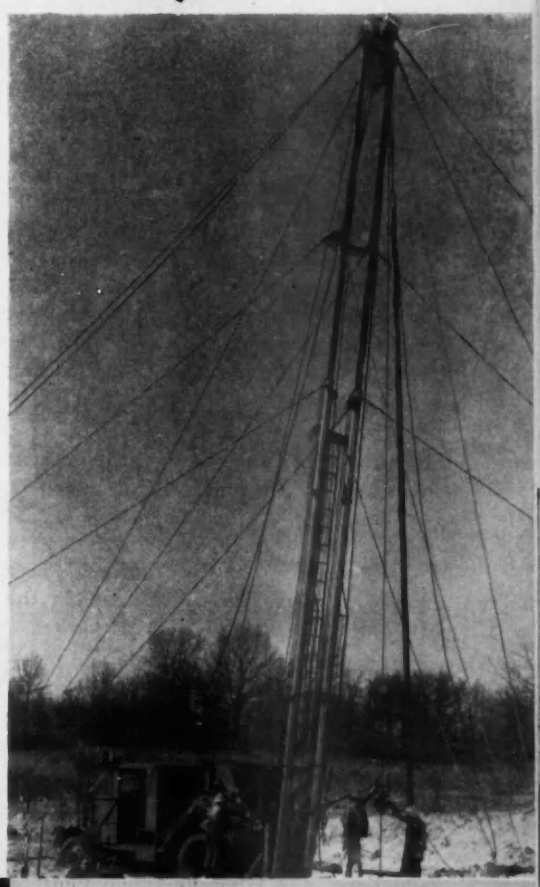

Mobilhoist with jerkline spudder assembly deepening a 3,300-foot well in Oklahoma. Air-disc friction clutches in both drums give fast, positive engagement.

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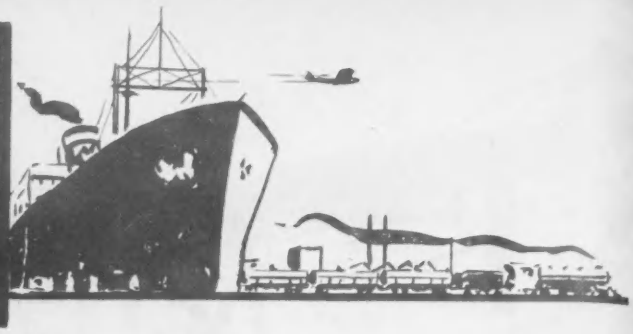

OPPOSING views on the need for government restrictions on petroleum imports were given wide publicity in July. Imports were severely denounced in Washington in a two-day meeting of the Executive Committee, Import Policy Committee, and vice presidents of the Independent Petroleum Association of America. A short time earlier, oil import were stoutly defended at the hearing of the House Small Business Sub-committee in New York, where importing company officials were supported by a spokesman for independent oil marketers in opposing new restrictions on imports.

Rising imports already are seriously curtailing domestic exploration and drilling, asserted IPAA leaders. Ed Warren, Midland, Texas, stated that fewer than 2000 rigs are now running in the U. S., compared with 2400 at the beginning of the year. In some areas the decline in drilling is drastic. Only 28 rigs are reported running in Wyoming, against 203 six months ago. H. P. Nichols, Tyler, Texas, told IPAA that in Mid-Central Texas 50 percent of the normally operating 400 rigs are now idle. One Dallas contractor reported a complete shutdown of his 32-string operation. IPAA was informed that only 50 rigs have been sold this year in the U. S. as compared with 800 sold last year. In the Penn-grade area, drilling program curtailment has reached 75 to 80 percent, it was stated.

IPAA officials bitterly attacked recent testimony of Eugene Holman, president of Standard Oil Company (N. J.), that importation of residual is necessary to meet demand. On the contrary, says IPAA, residual is backing up in the Mid-Continent, begging for a market.

"Excessive imports of crude and products are seriously injuring our domestic oil industry," asserted IPAA in a statement. "This is evidenced in production cutbacks this year of nearly 1 million barrels daily, with loss to our economy of almost 1 billion dollars annually, more than 30 field and area crude price reductions, and labor unemployment.

"Imports are unregulated and have not been reduced. These increased imports are favoring the competitive position of a few large corporations at the expense of thousands of domestic oil operators."

So crucial is the import problem that the state department has stepped in with the request that the importing companies explore the possibility of a voluntary reduction in their volume of imports. However, IPAA, distrustful of voluntary action, has officially endorsed Senator Elmer Thomas' amendment to the reciprocal trade agreement by which oil imports would be restricted to not more than 5 percent of domestic demand on a quarterly basis. Also, IPAA has endorsed the Milliken proposal for reinstating the "peril point" provisions formerly in the trade agreements, under which tariff reductions could be set aside when imports reach the point of imperiling domestic industry.

Danger Denied

At the New York hearing of the House committee, witnesses denied that imports endangered the domestic industry and asserted that increased imports are essential. For the first time unexpected and active support of the major importing companies came from an independent sector of the domestic industry. Harry B. Hilts, secretary of the Empire State Petroleum Association and secretary of the Atlantic Coast Oil Conference, distributor organizations, said "foreign oil is absolutely necessary for the secondary resellers and the oil-consuming public of this nation."

The committee staff, headed by O. H. Ellis, failed in its attempt to win admissions from any of the witnesses that the American oil market is threatened with a "potential" flood of foreign oil. The committee was visibly shaken in its conviction up to that time that foreign oil imports are a menace to wide areas of the domestic industry.

Eugene Holman, Standard president; Howard Page, assistant to Holman; H. M. Herron, chairman of the board of the Bahrein Petroleum Corporation and of California-Texas Oil; L. M. Snyder, assistant to the president of Arabian American Oil Company; and John A. Walstrom, vice president of Asiatic Petroleum Corporation, in addition to Hilts, all testified foreign oil is needed in the U. S. and is no more than supplementing domestic production. They based their argument on:

1. Precariously low level of residual stocks in the country at the present time, lowest levels of the year in the East Coast and Gulf Coast regions. Jersey Standard officials say even with no demand increase, they are forced to import residual fuel oils to meet current customer demand.

2. Increased residual and distillate demand that is anticipated later this year. Hilts estimated that along the Atlantic Seaboard and the Middle Atlantic States alone, 25 million barrels more of fuel oil would be required for the heating season of 1949-1950 than were needed for the previous peak demand season of 1947-1948.

3. Far from Middle East oil threating to flood the domestic market, Middle East production is already tapering off. Snyder testified that June output by Aramco in Saudi Arabia reached the year's low and that while a year ago Aramco had foreseen a 1953 production of 700,000 barrels daily, the company now planned to hold output to around 500,000.

Hilts charged before the House subcommittee that the action of the Texas Railroad Commission in cutting back allowables was motivated by a desire "not of conservation but to hold up prices." He predicted that "The Atlantic seaboard will depend more and more on foreign crude," and added: "Many competent oil observers see in the present agitation for import restrictions nothing more than an effort to maintain crude prices. Those proposing these restrictions seem unwilling to depend upon the economic laws of supply and demand, and are willing to call upon government to legally help them fix prices."

He said the high price of crude, artificially maintained, is responsible for putting many independent refiners out of business. "We look for trouble," he said, "in the next heating season as the direct result of the failure to allow crude oil prices to seek their own true economic level in relationship to finished product prices. In seeking to maintain crude prices by the use of conservation as a guise, those who have resorted to this method have brought the industry to a point where enormous cutbacks in refining operations have become necessary."

By HENRY OZANNE,
Staff Writer

COMPLAINTS FROM consumer groups and from within the industry itself, criticizing prices of crude oil and petroleum products, are being investigated by Congressional committees. The criticism is being answered effectively by industry representatives who show that oil prices are relatively lower than most other prices generally. However, the complaints and investigations show that federal government intervention is a serious threat to the industry.

DURING the shortage period of the postwar years, the petroleum industry was under fire from many quarters because of alleged monopolistic practices and policies. It is now no secret that Congressional hearings had developed such a mass of protest against the major company sector of the industry that a petroleum industry regulation bill was actually to have been put before Congress in the winter of 1947. Yet this regulation threat to the industry did not die with the end of the shortage. On the contrary, and despite the fact that many industry officials themselves do not realize it, government intervention in the oil industry is still a danger. Many observers feel that the basic danger is more now than at any time in the past.

The criticism that could lead to government control is coming chiefly from within the industry itself. It is centering on production practices and prices. One of the most prominent forums for the issue promises to be the Senate Banking and Currency Subcommittee on Small Business (the Maybank Committee). Senator Maybank himself, chairman of this investigatory group, says his inquiry may last more than one year and will be among the most thorough investigations ever conducted into the oil business. When the hearings were opened recently, another member of the subcommittee, Senator Charles W. Tobey, said: "Is this going to be just another inquiry with padded gloves, or are we really going to get down to the guts of this thing and find out what's wrong? A lot of little people are suffering; this is not for the gallery—I'm one of them."

The occasion was the initial attack on the oil industry on the charge that the price of gasoline is high "because the market has been rigged." This charge was laid before the Senators by an industry representative, W. L. Heinz, secretary of the South Carolina Oil Jobbers Association, who asserted: "This artificial gasoline price—and it is artificial—is being supported by the curtailment of crude production." He charged that the large oil companies are working with the oil-producing states to hold down crude production and thereby set the price of gasoline.

Cost of Living Index

A. L. Nickerson, director and executive in charge of domestic marketing for Socony-Vacuum Oil Company, replied to Heinz' charges with figures to show that the price of gasoline has not gone up so fast as the cost of living index, but he received some rough handling by the Senators listening. Senator Tobey retorted: "Yes, but everything else has come down or is at least standing still. The increase in the price of gasoline stands out like a sore thumb."

The staff of the Senate Banking and Currency Committee circulated a prepared study attacking the gasoline price

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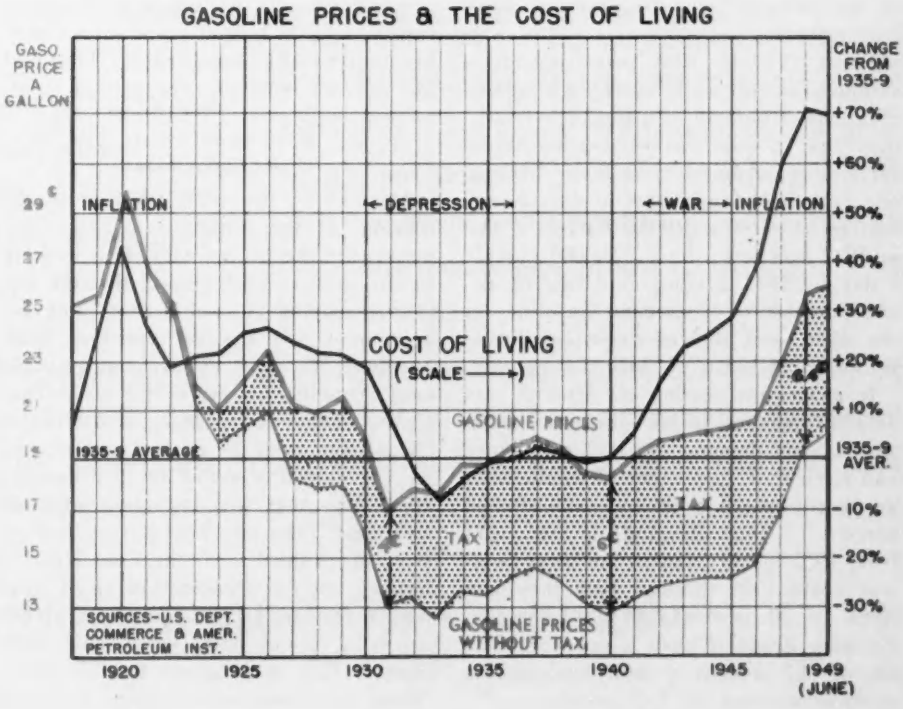
GASOLINE PRICES & THE COST OF LIVING



Oil Facing Stiffer Competition

By HENRY OZANNE,
Staff Writer

IMPROVED coal-burning equipment and a huge expansion program in the distribution of natural gas will offer the petroleum industry stiff competition in the heavy oils and middle distillate range. A few years ago such competition from solid fuels was considered a thing of the past. The home-heating market was inconsequential, and the oil industry's chief business was gasoline. Other products produced in the process of refining gasoline were sold at the best price they could bring.

But with the development of the light burning oil market, a wholly new turn was given the economics of petroleum marketing. Dr. Courtney Brown, head of the economics department of the Standard Oil Company (N. J.), points out that this market was developed beyond the by-product status when it was recognized as a means to iron out peaks that occurred in the oil market in the summer and troughs that occurred in winter. By 1934 winter demands for all oils were about as high as previous summer demands. By 1948 winter demands were 700,000 barrels a day more on the average than the previous summer demands.

From 1932 to 1948 petroleum consumption in the U. S. increased at a rate of about 6 percent compound annually over that 17-year period. During those same years demand growth for heating oils was even more spectacular. A requirement of only 269,000 barrels a day in 1932 was pushed to 1,235,000 barrels a day by 1948, a compound rate of annual increase of 10 percent. Gasoline, on the other hand, showed a compound consumption increase of only 5.4 percent.

In 1932 light heating oil demand was only 12 percent of all domestic crude and product demand. By 1948 this figure had risen to 21½ percent of total. Light burning oils made an increase of 14.4 percent of total demand in the years from 1932 to 1941, but in the three postwar years 1946 through 1948 they had risen to 20 percent of total demand. Gasoline dropped from a pre-war average of 44.7 percent of total demand to a postwar average of 40.7 percent.

These figures show that the economic health of the petroleum industry is becoming increasingly bound up with the economics of the middle distillate range of products.

And strange to say, that is just where coal is taking on a new competitive significance. This due to the fact that the middle distillate range of oil products is the most influenced by competitive prices. A change in the price of light heating oils readily influences demand. A space heater which the consumer can buy for a $100 and install himself will consume 14 to 16 barrels of fuel a year, or almost as much fuel as is consumed by an automobile costing $3000 to $4000. In 1947 it was cheaper on a straight heat content basis to burn convenient liquid fuel to heat homes than it was to use solid fuels, and oil burner installations were at record levels, resulting in scarcity of heating oil and higher fuel oil prices. The scarcity and higher prices of oils then reacted against oil burner installations and heating oil demand in 1948 and worked to the advantage of coal. In 1949 prices of fuel oils have declined rather drastically, with these oils in oversupply, and oil burner installations have been materially accelerated. Thus oil has offered varying degrees of competition with coal.

Coal Economizes

Meanwhile, the coal industry is not leaving all the initiative in this competition to the oil industry. It is seeking to cut costs of coal mining through improved machinery, and is promoting development and use of improved coal-burning equipment, endeavoring to make coal attractive in price and convenient to use. The coal industry is pushing a "heat your home by coal" program, and has developed a series of coal-burning appliances that are far more efficient and clean than any ever before known. Now in its third year, the Coal Heating Service has an organization of 54 local retailer setups at the community level, involving about 1500 retail coal merchants. This is a cooperative merchandizing and promotion campaign by which coal producers, through the National Coal Association, match funds and give professional advice and service to groups operating at the community level.

The new home coal-burning unit is a smokeless stove, clean in operation and inexpensive in fuel use. One typical device has been perfected by the Bituminous Coal Research Institute. This burner uses all kinds of bituminous coal, creates no smoke and leaves no clinkers. In this device air is taken in at one side of the burner below the level of the top of the fuel bed. The air passes down and across the bed, and the gases pass underneath an arch before they are conducted up to the pipe outlet. This arch has an opening along its entire length through which "secondary air" is admitted. This air mixes with the hot gases from the burning fuel as they pass under the arch and are completely burned.

The time between refueling is 12 to 24 hours for normal winter operation. The firing door automatically operates a fume vent to prevent fumes from coming out when the door is opened. As no air is drawn in at the bottom, the ash pit door is kept closed at all times except when a new fire is lighted or the fine ashes are removed.

In the industrial field, coal considerably bettered its competitive position with oil during 1947 and 1948. When residual fuel oil prices were climbing toward their peak in 1948, many industrial plants went back to their coal standby facilities. Since the beginning of 1949, supply of residual has exceeded demand and prices have come down sharply putting oil back into strong competition with coal.

One thing that makes coal a strong competitive fuel with oil is its still widespread established use despite the increase of oil consumption in recent years. This was pointed out earlier this year by James D. Francis, president of the Island Creek Coal Company of Huntington, W. Va. Addressing a fuel engineering conference at Detroit in connection with the American Society of Mechanical Engineers, Francis said:

Hurricane *in* Louisiana

A HOT STILLNESS pressed down on Crowley, Louisiana, that August afternoon in 1940. Sweat stood on foreheads . . . breath came in gasps . . . sounds seemed to echo through the humid air. Nothing moved but tiny little whirlwinds, bustling at street corners. The whole town seemed to be waiting

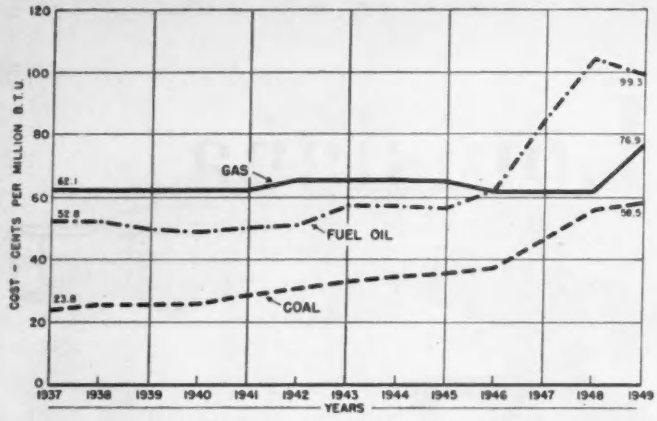
Ten minutes later it hit. A savage hurricane crashed over Crowley. The wind roared . . . the bottom dropped out of the sky . . . 26 inches of rain cascaded on the prostrate community in 36 hours.

Continental Oil Company's bulk plant was the only oil storage that escaped. Conoco Agent Jack Lawrence immediately put himself and the company's plant at the service of the Red Cross. Fuel for all evacuation and rescue boats was available to everybody who could help. Kerosene was rushed to hospitals and first aid stations to provide the only illumination. Agent Lawrence himself used his personal boat to take the doctor wherever he was most needed.

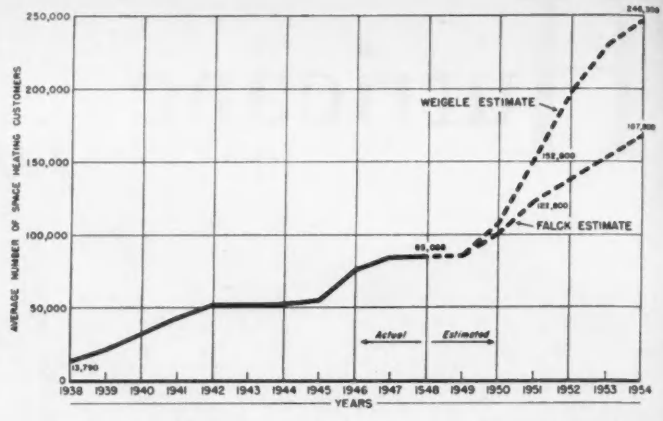
Such service to the community is the dominant principle of the oil industry. Jack Lawrence's feeling of obligation to his neighbors is not unique . . . it is traditional with the men and women who produce, manufacture and distribute petroleum products throughout the United States.

Four generations of men like Jack Lawrence have helped build Continental's 74-year-old record of stability. Thousands like him today are a vital part of our program for growth.

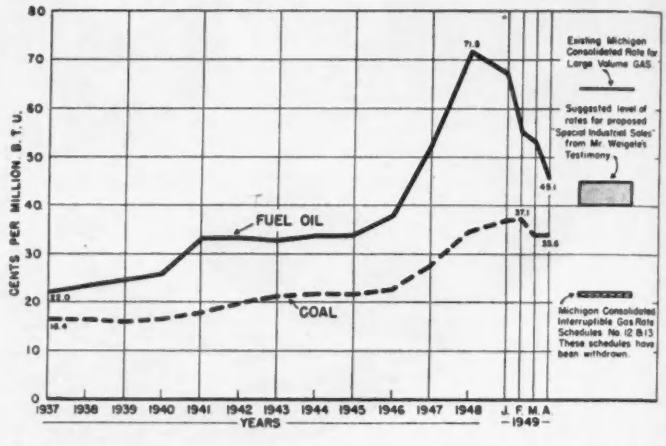
CONOCO **Continental Oil Company**



Sources: Gas, AGA Rate Service; Natural 1000-1014 Btu per cubic foot. Coal, Bureau of Labor Statistics; Eastern High Volatile Stoker, 13,800 Btu per pound. Fuel Oil, Bureau of Labor Statistics and Platt's Oil Price Service No. 2, 138,500 Btu per gallon.



Source: Michigan Consolidated Gas Company reports to Michigan Public Service Commission.


CENTS PER MILLION B.T.U.
80
70
60
50
40
30
20
10
0
FUEL OIL
COAL
Existing Michigan Consolidated Rate for Large Volume GAS
Suggested level of rates for proposed "Special Industrial Sales" from Mr. Wengelers Testimony
Michigan Consolidated Interruptible Gas Rate Schedules No. 12 & 13 These schedules have been withdrawn.
1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 J F M A 1949
YEARS

Source: Coal data from Bureau of Labor Statistics Wholesale Prices. Oil data from Platt's Oilgram. Oil prices based on quoted prices at Lake Terminal plus 25 cents per gallon estimated delivery and handling charges. Conversion factors: Coal, 13,000 Btu per pound equal to 26 million Btu per ton. Oil, 152,000 Btu per gallon; 6.58 gallons of oil equal 1 million Btu. Note: Indicated prices are spot prices. Large industrial or utility users with long term contracts can generally shade these prices by about 75 cents per ton on coal and 1 cent per gallon on oil.

TOP LEFT: Fuel costs for house heating in Detroit.
TOP RIGHT: Growth in number of gas space heating customers in Detroit.
LOWER RIGHT: Trend of industrial fuel prices in Detroit, 1937-49.

"Coal today is:

"1. Providing fuel for one-half the homes and apartments of the nation.

"2. Providing fuel for 68.5 percent of all the railroad locomotives in use in America.

"3. Furnishing fuel and power for 66 percent of the nation's manufacturing plants.

"4. Furnishing the fuel used in generating 54 percent of all electric power in the nation."

The significant fact in the current coal utilization program is that for the first time coal is threatening to take away markets that previously were captured from it by oil. Not only is that true of the home-heating field and industrial plants, but also it is claimed that railroad dieselization will be slowed because of the newly developed coal-burning locomotive. This engine is a gas turbo-electric unit which uses pulverized coal to develop its 4500 horsepower.

The outlook was summarized recently by Robert M. Bartlett, vice president of the Gulf Oil Corporation, who said that the competitive battle "of the two giants, coal and oil, is on again in full force." In that struggle oil has much further to go than coal. Bartlett noted that while 45 percent of the American families surveyed expressed preference for central oil heat for their homes, only 20 percent to date have oil furnaces installed.

However, not coal but natural gas is the relatively new competitor that may change the whole economics of the petroleum industry again. Even now this once discarded nuisance of the oil fields provides a seventh of all energy produced in the U. S. From a mere regional fuel it is rapidly becoming national in character. Consumption has risen from 339 billion cubic feet in 1906 to 4.4 trillion cubic feet in 1947, a volume carried through a nationwide system of 243,000 miles of pipe lines. Standard Oil Company officials predict that by 1952 a network of 261,300 miles of pipe line will transport and deliver 9 trillion cubic feet a year of natural gas.

Construction Expenditures

Construction expenditures by all natural gas utilities in the U. S. in 1938 amounted to only $79 million, but by 1945 had soared to $126 million. Since then the increase in investment has been even more astounding: $236 million for 1946; $623 million for 1947; and $675 million for 1948. The American Gas Association estimates that natural gas construction expenditures will aggregate nearly $2 billion for the four-year period 1949-1952.

Only gradually will natural gas come into direct competition with oil at the home level. Much of the increased volume to be distributed will go as enrichment for manufactured gas in place of fuel oil. Meanwhile, oil burner sales for household use are expected to climb. L. E. Ulrope, vice president of Esso Standard Oil Company, predicts a sale of 1,387,000 new oil burners in the next four years—nearly as many as the 1½ million sold during the ten-year period from 1929-1939.

Yet there has always been a consumer tendency to convert burners to natural gas as rapidy as gas became available. Standard Oil Company (N. J.) officials say the reason for this is "basically, because gas is the cheapest of the three principal fuels in most places where it is available, and because it is by far the most convenient." Natural gas on the average costs only a little more than one-third the price of manufactured gas and yields twice as much heat. And, according to the Bureau of Mines, domestic users account for 24.6 percent of all the natural gas now being used.

A case history of the competitive inroads of gas against both oil and coal is provided by Edward Falck for the city of Detroit. Falck is a well-known gas consultant and has held many posts in both industry and government. In the spring of 1949 he investigated the historical trend of gas, coal and oil prices in Detroit from the standpoint of their impact on future domestic heating sales

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 29th YEAR

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Feel it in the Handling!
Check it on the Scales!

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. . . and Light Weight is only ONE of *many* "DU" advantages!

Stop and think how many dozens of times the rotary slips are lifted by the drilling crew during a *single* round trip. Multiply this by repeated day-after-day, month-after-month operations and you can readily appreciate why light weight is such an important factor to look for in rotary slips. *And you really get light weight in Baash-Ross "DU" Rotary Slips!*

For example, check these figures on typical sizes of "DU" Slips . . .

Size of "DU" Rotary Slips	"DU" Regular (12" long)	"DU" Long (16" long)
4½" O.D. Slips with 4½" Liners	137 lbs.	158 lbs.
5⅝" O.D. Slips with 5⅝" Liners	146 lbs.	177 lbs.
7" O.D. Slips with 7" Liners	154 lbs.	196 lbs.

On these and other sizes you'll find Baash-Ross "DU" Rotary Slips are pounds lighter because all excess metal has been removed without in any way sacrificing strength or ruggedness. *Notice the deeply-cored backs that replace dead metal with a cellular rib construction that combines more-than-ample strength with minimum weight.*

▶ But most important is the fact that unusually light weight is only *one* of many important advancements you get in Baash-Ross "DU" Rotary Slips. Carefully check through the features outlined below . . . compare them right down the line with *any other* make of slips . . . and you'll see why "DU" Rotary Slips are today's outstanding buy for maximum convenience, safety and all-around economy!

Baash-Ross "DU" Rotary Slips are available in both "Regular" length (12" long—for wells through 8000 ft. in depth) . . . and "Long" length (16" long—for the deepest wells and heaviest drill strings). For full details, see your nearest Baash-Ross representative—or write direct!

WHAT OTHER SLIPS COMBINE SO MANY OUTSTANDING ADVANTAGES?

▶ **3 BODY SIZES FIT 14 PIPE SIZES:** With "DU" Slips you don't need a separate slip for each size of drill pipe. By simply changing the liners—a quick inexpensive operation—three basic "DU" body sizes fit *all* sizes of tubing, drill pipe and casing from 2⅜" O.D. through 7" O.D. Cuts slip investment and maintenance to a minimum!

▶ **MONEY-SAVING SEGMENTED LINERS:** "DU" Slip Liners are in 4" segments instead of single long units. If you use both 12" and 16" Slips there's no need to stock liners for both sizes. Simply keep a supply of 4" segments on hand—use three 4" segments for 12" Slips . . . four 4" segments for 16" Slips . . . thus greatly reducing inventory costs. Also, if for any reason slip wear is concentrated at one point, liner segments can be switched or inverted to distribute wear without replacing any parts. Or if too worn, replace only the worn segments and use the others for additional service. Cuts maintenance costs to the bone!

▶ **SELF-ALIGNING HINGE:** "DU" Body Segments are not merely hinged together, but are unitized by a unique "floating" hinge that prevents vertical misalignment, yet permits them to adjust laterally to any irregularities in bore of master bushing. This assures a full, uniform grip under all conditions!

▶ **SAFETY LINER RETENTION:** "DU" Slips are so designed that *all* stresses—both of supporting the pipe and of breaking out joints—are transmitted directly from the liners to the slip body. There are no retaining bolts or pins to become sheared and allow liners to fall into hole. Yet liner segments can be quickly removed by simply pulling a cotter and sliding out one keystone retaining key. This double keystone key firmly mates liners and body into single rigid unit!

▶ **AND OTHER ADVANTAGES:** There are still other vital "DU" advantages . . . the safety loops on the handles that safeguard crew's hands against injury . . . the polished backs that eliminate sticking in the bore . . . the perfected grip design that will not damage the pipe . . . the flattened toes that enable "DU" Slips to stand solidly on table or floor . . . and many other unique features.

BEFORE YOU BUY ANY ROTARY SLIPS GET THE COMPLETE STORY ON "DU" ALL-AROUND SUPERIORITY!

and on future industrial sales. He says:

"The principal factors affecting the market for gas space heating are, first, population; second, general economic conditions in the area, including employment and per capita income; third, distribution of dwelling units among different types of structures, single-family, two-family and multiple-family; fourth, the availability and the relative prices of gas, coal and oil; fifth, the cost and relative convenience and operating characteristics of fuel-burning equipment, including particularly the cost of conversion from one type of fuel to another."

In Detroit, he found the difference in fuel use between 1940 and 1947 shows that almost all the conversions were from coal to gas.

"Before the war," he explains, "both coal and oil were cheaper than gas in Detroit. In 1940, for example, gas for house-heating in Detroit was priced at 62.1 cents per million British thermal units as compared with 25½ cents for coal and 49.1 cents for oil. Coal was selling at a price equivalent to 41 percent of the price of gas, and fuel oil at a price equivalent to 79 percent of the price of gas. There was no substantial change in the price of gas through 1948.

"Then early in 1949 the gas rate was increased by a surcharge amounting to 14½ cents per thousand cubic feet, bringing the price of gas for house-heating to approximately 76½ cents per million BTU's as of March, 1949. Coal has more than doubled in price since before the war. In 1940 coal sold at $7.67 a ton; by 1945 it had gone to $10.45, and in February, 1949, it was selling at $16.15.

"No. 2 fuel oil was selling in 1940 at about 6.8 cents a gallon. During the war years the price was stablized by OPA at 7.9 cents a gallon. In the last quarter of 1947 fuel oil reached a peak of 15 cents a gallon. It declined to 14.1 cents in the last quarter of 1948, and was selling at 13.7 cents during the first quarter of 1949. As of February, 1949, gas was selling at 76.9 cents per million BTU's; coal at 58.5, and No. 2 fuel oil at 99.3 cents. During the early postwar period fuel oil was much more expensive than gas, and coal was about a standoff with gas on a BTU equivalent basis of comparison. With the application of the surcharge rate to gas and the declining trend in oil prices, the spread between gas and oil in Detroit has been substantially reduced, but nevertheless gas continues to be substantially cheaper than oil."

The Detroit case well illustrates how decisively gas competes against both oil and coal in an area where the factors of supply and price favor gas. In the next five years those areas will be extended widely over the country.

Criticism of Prices

■ CONTINUED FROM PAGE 39

structure. The report said in part: "The reaction of the consuming public to the gasoline price rise is indicated by a statement of the president of the American Automobile Association, pointing out that gasoline price increases during the last three years are costing motorists about $1300 million a year. Since the average motorist uses about 650 gallons of gasoline a year, the increase in prices during the last three years means that, aside from any tax increases, the average motorist is now paying $40 a year more for the same amount of gasoline than he did in the spring of 1946."

Committee's Analysis

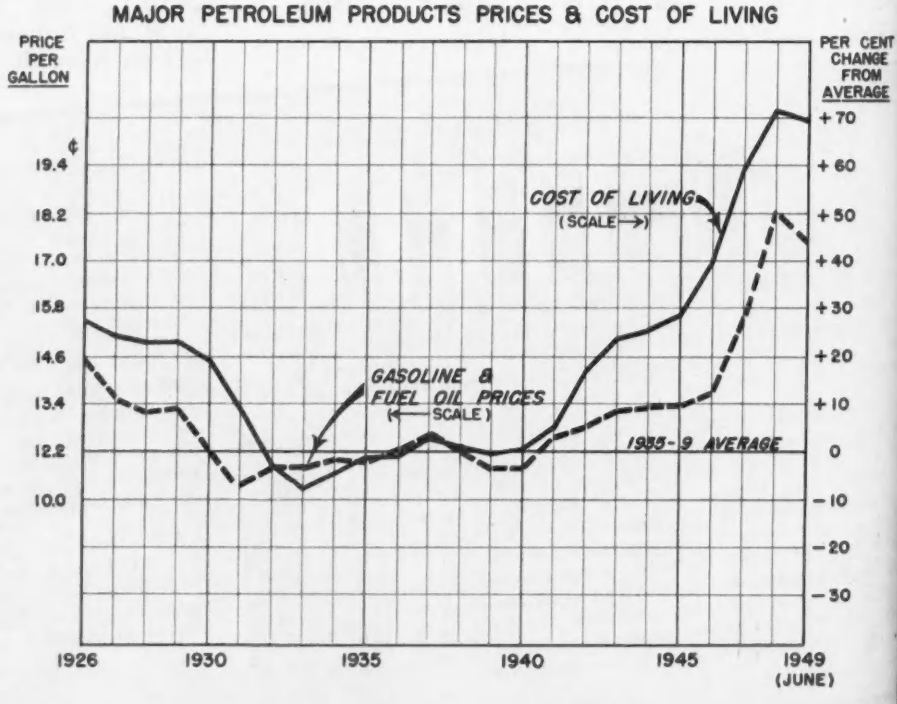
The Committee's staff analyzed industry's explanation of the price rises and rebutted: "We have two arguments in favor of higher prices: the first covers the period of high demand; the second covers the period of lowered demand. Put the two arguments together and one of them always applies, thus providing a continuous justification for high prices. And if the reasoning that a decline in profits affords a justification for restricting production and raising prices should be generally applied, one may wonder as to the extent to which production throughout the economy is to be curtailed in order to raise prices. If there is one fairly sure way of spiraling this country into a business setback substantially greater than has already occurred, the sure way would seem to be offered by a policy of restricting production in order to hold up prices."

Nickerson explained that recent price rises in gasoline have resulted from changes in the relative demand for products. He said:

"During the period from December 1, 1948, to March 30, 1949, the price decreases on fuels began to put severe economic pressure on the independent refiner and on the integrated operator as well. The prices of crude oil, wages and materials remained unchanged and yet refinery prices slid substantially and refinery margins suffered accordingly. This is shown by the fact that refinery margins at the Gulf Coast in 1947 were 79 cents, in 1948 they were 75 cents, in 1949 they were 59 cents, and in May of 1949 they were only 48 cents."

Even though the price of gasoline increased in April, the refiners' margin (which is the difference between the posted price of crude and the refinery realization) continued to decrease, Nickerson showed.

"Even after the price increase," said Nickerson, "the gasoline index is still substantially lower than that of the cost of living. Since 1935-1939 gasoline prices have increased up to June, 1949, by only 39 percent, while the cost of living (Bureau of Labor Statistics) is up 70 per cent. The net result to the consumer is that today he is paying 1.26 cents per gallon more for gasoline, but 1.5 cents a gallon less for kerosine, 1.5 cents a gallon less for No. 2 heating oil, and 2.75 cents per gallon less for fuel oil. This means that Socony-Vacuum customers are paying a net of .567 cent per gallon less for a composite gallon of petroleum products than they did a year ago."



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CHICAGO

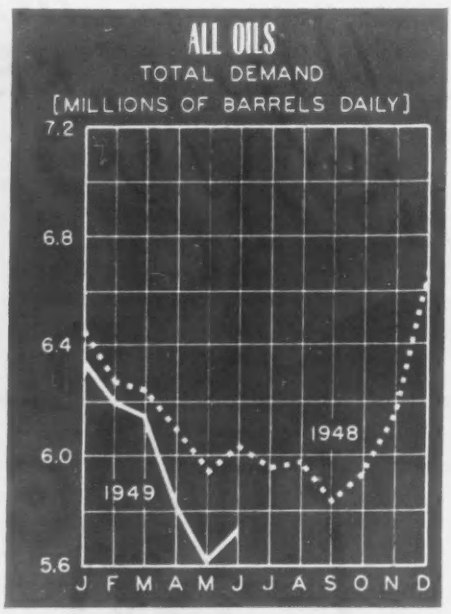
Outlook for *Demand* Favorable

By L. J. LOGAN
Associate Editor

IN THIS period of reduced business activity, as in similar periods of the past, the petroleum industry has had its traditional advantage of relatively stable demand for its products, and it may be expected to continue to hold that advantage.

It is still expected that for this year as a whole there will be a small increase over last year in the total demand for all oils. Motor fuel demand for 1949 is expected to be about 5 percent greater than in 1948, largely due to greater use by passenger cars. Some forecasters estimate that demand for kerosine and distillate fuel oils for 1949 as a whole may show increases of as much as 10 percent over 1948, as installations of new oil burners are running relatively high this year, while normal weather in the latter part of the year would contrast with milder than normal weather a year previously. Although residual fuel oil demand has been lower in 1949 than in 1948, lower prices are materially improving the outlook for sales to electric utilities, industrial concerns, and other users.

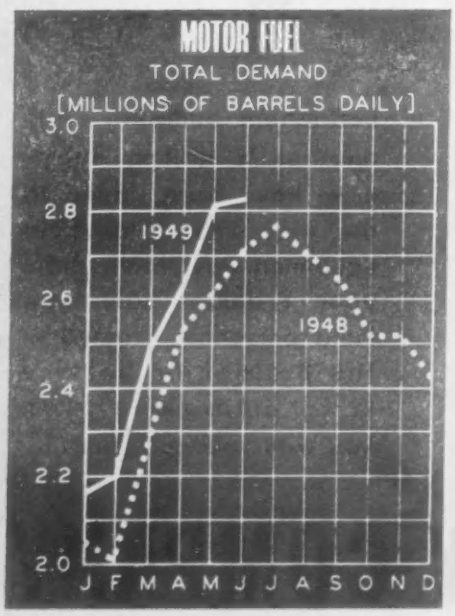
In the first six months of 1949 the total demand for all oils averaged 5,971,000 barrels daily, a decrease of 3.2 percent from the 6,168,000 daily of the first half of 1948. This decrease occurred in spite of an increase in motor fuel demand and reflected substantial declines in sales of kerosine, distillate fuel oil, residual fuel oil, and lubricants. The lower demand for light and heavy fuel oils was due in part to the general business decline but resulted especially from the fact that last winter's weather was warmer than normal.

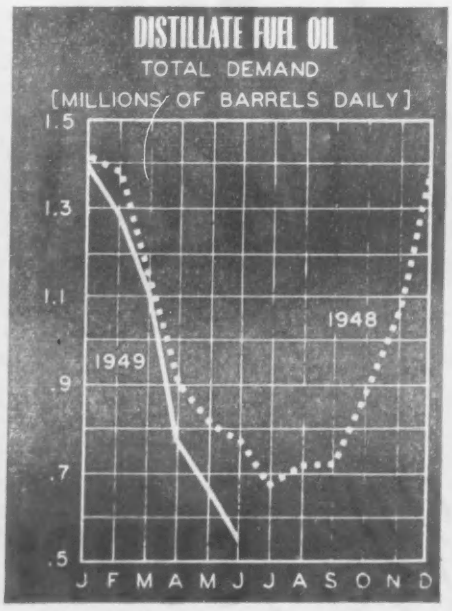


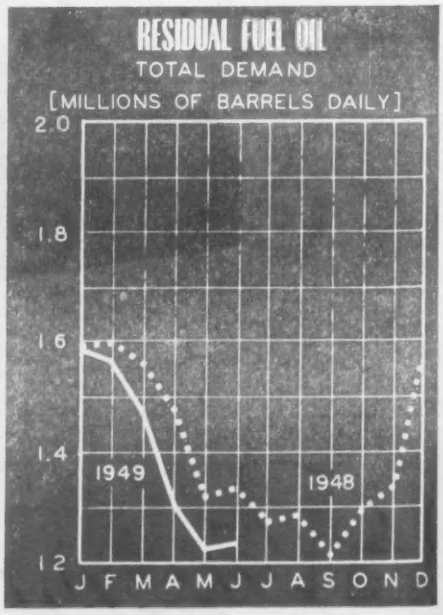
(SEE TABLE ON PAGE 48.)

In curtailing supply to conform with lower demand, domestic production of crude oil was cut to an average of 5,145,000 barrels daily in the first half of 1949 from 5,429,000 barrels per day in the like period of 1948, a decrease of 5.2 percent. Natural gasoline production was increased to 416,000 barrels daily from 389,000 daily, a gain of 6.9 percent. Imports of refined products were practically the same as last year in averaging 171,000 barrels daily. But imports of crude averaged 408,000 barrels per day in this year's first half, up 34.2 percent from the 304,000 daily of last year's first six months.

Daily average demand for motor fuel was 6.8 percent greater for the first half of 1949 than in the initial half of 1948, but there were decreases of 10.8 percent for distillate fuel oil, 16.5 percent for kerosine, 5.6 percent for residual fuel oil, and 16.5 percent for lubricants.







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Export Distributor: Bethlehem Steel Export Corporation

Demand for and Supply of All Oils, Crude Oil, Motor Fuel, Kerosine, Fuel Oil, and Lubricants

Sources: U. S. Bureau of Mines except May and June, 1949, estimated with aid of A.P.I. reports

(THOUSANDS OF BARRELS)

ITEM	First Half 1948	First Half 1949	Percent Change
ALL OILS			
Domestic Production, Total	1,069,052	1,006,457	— 5.0
(Daily Average)	5,819	5,561	— 4.4
Crude Petroleum	988,011	931,182	— 5.8
(Daily Average)	5,429	5,145	— 5.2
Natural Gasoline	70,851	75,209	+ 6.2
(Daily Average)	389	416	+ 6.9
Benzol	190	66	— 65.3
(Daily Average)	1	.....	.....
Imports, Total	86,573	104,858	+ 21.1
(Daily Average)	476	579	+ 21.6
Crude Petroleum	55,262	73,870	+ 33.7
(Daily Average)	304	408	+ 34.2
Refined Products	31,311	30,988	— 1.0
(Daily Average)	172	171	— 0.6
Changes in Stocks, All Oils	+23,106	+30,592	.....
(Daily Average)	+ 127	+ 169	.....
Stocks, Beginning of Period	500,800	605,189	+ 20.8
Refinable Crude	224,929	246,199	+ 9.5
Heavy Crude in California	5,725	10,055	+ 75.6
Refined Products	265,850	343,356	+ 29.2
Natural Gasoline	4,296	5,579	+ 29.9
Stocks, End of Period	523,906	635,781	+ 21.4
(Days' Supply)	85	106	+ 24.7
Crude Petroleum	231,412	274,256	+ 18.5
Refined Products	286,417	354,025	+ 23.6
Natural Gasoline	6,077	7,500	+ 23.4
Demand, Total	1,122,519	1,080,723	— 3.7
(Daily Average)	6,168	5,971	— 3.2
Exports, Total	65,298	63,371	— 3.0
(Daily Average)	359	350	— 2.5
Crude Petroleum, Total	19,075	13,590	— 28.8
(Daily Average)	105	75	— 28.6
Refined Products, Total	46,223	49,781	+ 7.7
(Daily Average)	254	275	+ 8.3
Domestic Demand, Total	1,057,211	1,017,352	— 3.8
(Daily Average)	5,809	5,621	— 3.3
CRUDE PETROLEUM			
Supply:			
Domestic Production, Total	988,011	931,182	— 5.8
(Daily Average)	5,429	5,145	— 5.2
Imports, Total	55,262	73,870	+ 33.7
(Daily Average)	304	408	+ 34.2
Change in Stocks	+ 758	+18,002	.....
(Daily Average)	+ 4	+ 100	.....
Stocks, Beginning of Period	230,654	256,254	+ 11.1
Stocks, End of Period	231,412	274,256	+ 18.5
(Days' Supply)	40	50	+ 25.0
Supply, Total	1,042,515	987,050	— 5.3
(Daily Average)	5,729	5,453	— 4.8
Demand:			
Runs, to Stills, Total	99,672	968,935	— 3.1
(Daily Average)	5,493	5,353	— 2.5
Domestic Crude	946,293	896,213	— 5.3
(Daily Average)	5,200	4,951	— 4.8
Foreign Crude	53,379	72,722	+ 36.2
(Daily Average)	293	402	+ 37.2
Exports, Total	19,075	13,590	— 28.8
(Daily Average)	105	75	— 28.6
Transfers to Fuel Oil Stocks	12,736	4,182	— 67.2
(Daily Average)	70	23	— 67.1
Distillate Fuel Oil	1,841	1,520	— 17.4
Residual Fuel Oil	10,895	2,662	— 75.6
Used as Fuel, and Losses	11,032	343	— 96.9
(Daily Average)	61	2	— 96.7
Demand, Total	1,042,515	987,050	— 5.3
(Daily Average)	5,729	5,453	— 4.8
KEROSINE			
Production, Total	62,581	50,981	— 18.5
(Daily Average)	344	282	— 18.0
Percent Yield from Crude	6.3	5.3	.....
Imports, Total	135	.....	—100.0
(Daily Average)	1	.....	—100.0
Change in Stocks	+758	—365	.....
(Daily Average)	+ 4	— 2	.....
Stocks, Beginning of Period	17,722	23,895	+ 34.8
Stocks, End of Period	18,480	23,530	+ 27.3
(Days' Supply)	54	83	+ 53.7
Demand, Total	61,958	51,346	— 17.1
(Daily Average)	340	284	— 16.5
Exports, Total	1,635	1,882	+ 15.1
(Daily Average)	9	11	+ 22.2
Domestic Demand	60,323	49,464	— 18.0
(Daily Average)	331	273	— 17.5

ITEM	First Half 1948	First Half 1949	Percent Change
MOTOR FUEL			
Production, Total	445,538	470,493	+ 5.6
(Daily Average)	2,448	2,599	+ 6.2
Refinery Gasoline, Total	395,534	418,298	+ 5.8
(Daily Average)	2,173	2,311	+ 6.4
(Yield from Crude)	39.5	43.2	.....
Natural Gasoline, etc.	70,851	75,209	+ 6.2
(Daily Average)	389	416	+ 6.9
Less sales of L.P.G.	20,113	21,957	+ 9.2
Less transfers cycle prods.	924	1,123	+ 21.5
Benzol	190	66	— 65.3
Imports, Total	72	.....	—100.0
(Daily Average)	.....	.....	—100.0
Change in Stocks	+14,891	+13,047	.....
(Daily Average)	+ 82	+ 72	.....
Stocks, Beginning of Period	87,407	101,001	+ 15.6
Finished Gasoline	83,111	95,422	+ 14.8
Natural Gasoline	4,296	5,579	+ 29.9
Stocks, End of Period	102,298	114,048	+ 11.5
(Days' Supply)	43	45	+ 4.6
Finished Gasoline	96,221	106,548	+ 10.7
Natural Gasoline	6,077	7,500	+ 23.4
Demand, Total	430,719	457,446	+ 6.2
(Daily Average)	2,366	2,527	+ 6.8
Exports, Total	17,340	23,391	+ 34.9
(Daily Average)	95	129	+ 35.8
Domestic Demand	413,379	434,055	+ 5.0
(Daily Average)	2,271	2,398	+ 5.6
DISTILLATE FUEL OIL			
Production, Total	188,821	165,241	— 12.5
(Daily Average)	1,037	913	— 12.0
Percent Yield from Crude	18.9	17.1	.....
Transfers from Crude	1,841	1,520	— 17.4
(Daily Average)	10	8	— 20.0
Imports, Total	1,963	118	— 94.0
(Daily Average)	11	1	— 90.9
Change in Stocks	—3,643	—7,233	.....
(Daily Average)	— 20	— 40	.....
Stocks, Beginning of Period	49,478	71,381	+ 44.3
Stocks, End of Period	45,835	64,148	+ 40.0
(Days' Supply)	43	67	+ 55.8
Demand, Total	196,268	174,112	— 11.3
(Daily Average)	1,078	962	— 10.8
Exports, Total	11,668	8,192	— 29.8
(Daily Average)	64	45	— 29.7
Domestic Demand	184,600	165,920	— 10.1
(Daily Average)	1,014	917	— 9.6
RESIDUAL FUEL OIL			
Production, Total	235,894	221,432	— 6.1
(Daily Average)	1,296	1,223	— 5.6
Percent Yield from Crude	23.6	22.9	.....
Transfers from Crude	10,895	2,662	— 75.6
(Daily Average)	60	15	— 75.0
Imports, Total	27,746	29,987	+ 8.1
(Daily Average)	152	165	+ 8.6
Change in Stocks	+6,065	+1,864	.....
(Daily Average)	+ 33	+ 10	.....
Stocks, Beginning of Period	38,148	63,993	+ 67.7
Stocks, End of Period	44,213	65,857	+ 49.0
(Days' Supply)	30	47	+ 56.7
Demand, Total	268,470	252,217	— 6.1
(Daily Average)	1,475	1,393	— 5.6
Exports, Total	5,298	6,031	+ 13.8
(Daily Average)	29	33	+ 13.8
Domestic Demand	263,172	246,186	— 6.5
(Daily Average)	1,446	1,360	— 5.9
LUBRICANTS			
Production, Total	25,696	21,870	— 14.9
(Daily Average)	141	121	— 14.2
Percent Yield from Crude	2.6	2.3	.....
Change in Stocks	+465	+857	.....
(Daily Average)	+ 2	+ 5	.....
Stocks, Beginning of Period	7,701	9,843	+ 27.8
Stocks, End of Period	8,166	10,700	+ 31.0
(Days' Supply)	59	92	+ 55.9
Demand, Total	25,231	21,013	— 16.7
(Daily Average)	139	116	— 16.5
Exports, Total	6,841	6,800	— 0.6
(Daily Average)	38	38	.....
Domestic Demand	18,390	14,213	— 22.7
(Daily Average)	101	78	— 22.8

Texas Hardest Hit by Cut in U. S. Production

ALTHOUGH 25 of the 48 states of the U. S. are producing petroleum, the four leading states, Texas, California, Louisiana, and Oklahoma, account for over three-fourths of the national output, based on data for June. Adding Kansas makes five states account for 82.4 percent. By including the next five largest producing states, Illinois, New Mexico, Wyoming, Mississippi, and Arkansas, ranking in that order, 95 percent of U. S. crude output is covered. Colorado yields 1.3 percent, putting 96.3 percent within 11 states. The remaining 14 producing states together yield 3.7 percent of U. S. output, each accounting for only a fraction of 1 percent.

Although Texas has sharply curtailed production this year, it remains by far the largest producing state. In June of this year Texas output averaged 1,929,000 barrels daily, which was 39.17 percent of the U. S. production of 4,924,100 barrels per day. This was 541,900 barrels a day less than Texas production of 2,470,900 barrels daily in June of last year, which represented 44.57 percent of the U. S. total of 5,544,400 daily in that month. The Texas reduction of 541,900 barrels daily from a year ago compared with a decrease of only 78,400 barrels per day for all other states in the aggregate, as total U. S. output was down 620,300 daily. Outside Texas, production is less than a year ago in Alabama, Arkansas, California, Kansas, Michigan, Mississippi, Montana, Nebraska, Oklahoma, Pennsylvania, and Wyoming. It is unchanged in Kentucky, Missouri, and Virginia. But increases are shown by Colorado, Florida, Illinois, Indiana, Louisiana, New Mexico, New York, Ohio, and West Virginia.

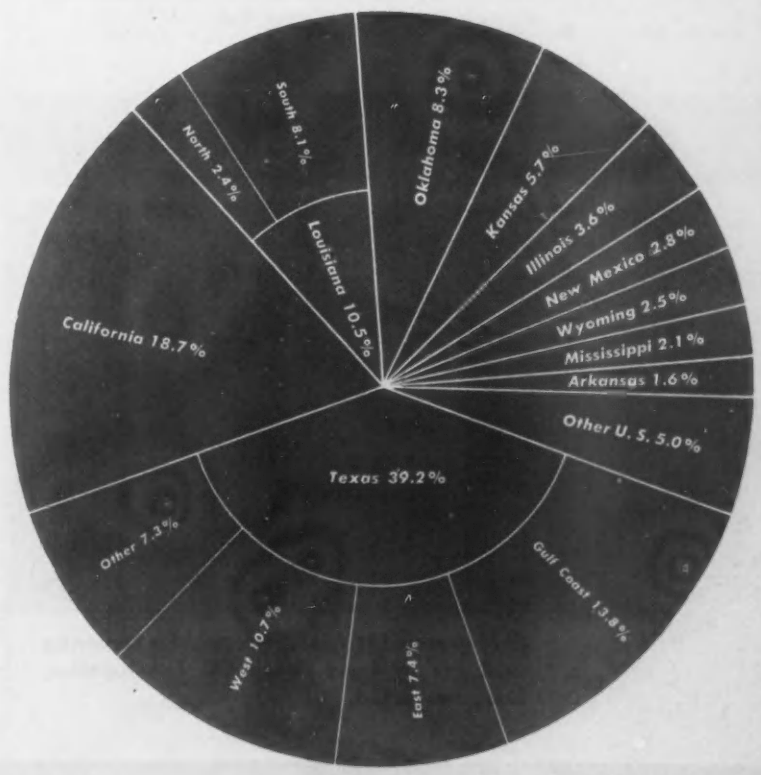
Aside from Texas, the only states which have cut production sharply enough to leave them with lower percentages of the U. S. total than a year ago are Michigan, Mississippi, Pennsylvania, and Wyoming, reflecting weak markets for heavy and Pennsylvania grade crudes. While Texas has cut back sharply, that state in 1948 was enjoying special postwar demands that only it was capable of meeting. Texas still accounts for 39.17 percent of U. S. production compared with only 36.51 percent in June of 1941. California now yields 18.74 percent of U. S. production, Louisiana 10.51 percent, Oklahoma 8.26, Kansas 5.73, Illinois 3.63, New Mexico 2.76, Wyoming 2.53, Mississippi 2.07, and Arkansas 1.62 percent.

U. S. Crude Oil Production by States

From U. S. Bureau of Mines, except June, 1949 estimated from A. P. I. weekly reports
(ACTUAL BARRELS)

STATE or DISTRICT	JUNE, 1948 Barrels Daily	JUNE, 1948 Percent of U.S.	JUNE, 1949 Barrels Daily	JUNE, 1949 Percent of U.S.
Alabama	1,400	0.03	1,200	0.02
Arkansas	85,600	1.54	79,700	1.62
California	948,900	17.12	922,800	18.74
Colorado	47,100	0.85	64,400	1.31
Florida	800	0.01	1,400	0.03
Illinois	177,900	3.21	178,600	3.63
Indiana	18,300	0.33	25,000	0.51
Kansas	313,300	5.65	282,300	5.73
Kentucky	23,700	0.43	23,700	0.48
Louisiana	493,600	8.90	517,300	10.51
North Louisiana	119,200	2.15	116,000	2.36
South Louisiana	374,400	6.75	401,300	8.15
Michigan	45,700	0.82	39,500	0.80
Mississippi	125,400	2.26	101,800	2.07
Missouri	100	....	100	....
Montana	26,800	0.48	26,400	0.54
Nebraska	700	0.01	400	0.01
New Mexico	127,700	2.30	135,900	2.76
New York	13,200	0.24	14,100	0.29
Ohio	9,800	0.18	10,000	0.20
Oklahoma	423,800	7.64	406,800	8.26
Pennsylvania	36,400	0.66	29,800	0.60
*Texas	2,470,900	44.57	1,929,000	39.17
Dist. 1—South Central	28,600	0.52	26,100	0.53
Dist. 2—Middle Gulf	173,700	3.13	121,100	2.46
Dist. 3—Upper Gulf	497,600	8.97	370,500	7.52
Dist. 4—Lower Gulf-S.W.	256,400	4.62	188,300	3.82
Dist. 5—East Central	47,000	0.85	34,600	0.70
Dist. 6—Northeast	433,900	7.83	329,800	6.70
Dist. 7-B—North Central	48,300	0.87	59,700	1.21
Dist. 7-C—West Central	46,000	0.83	42,200	0.86
Dist. 8—West	697,600	12 58	527,300	10.71
Dist. 9—North	139,900	2.52	136,600	2.77
Dist. 10—Panhandle	86,300	1.56	92,800	1.89
Utah	....	....	800	0.02
Virginia	100	....	100	....
West Virginia	7,500	0.14	8,200	0.17
Wyoming	145,700	2.63	124,800	2.53
Total United States	5,544,400	100.00	4,924,100	100.00

*Texas data by districts for 1948 are on API basis, and therefore do not agree exactly with the State total, which is on Bureau of Mines basis.

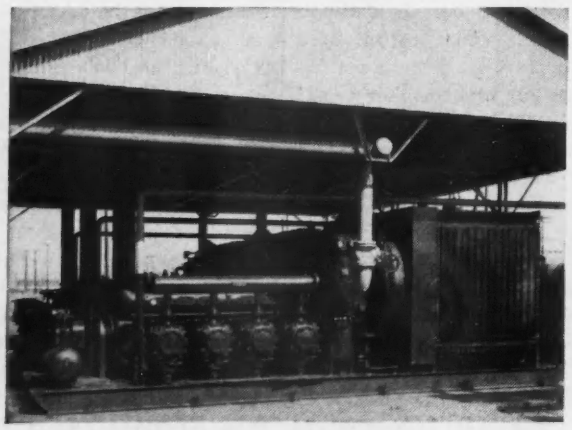


Percent of U. S. crude production by individual states. (Based on daily average production in June, 1949.)

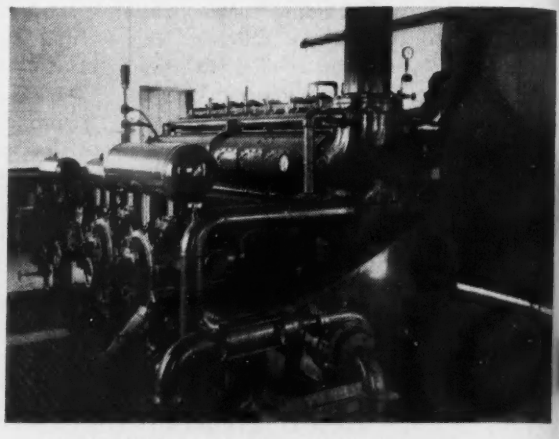
Here's on-the-job

FOR VERSATILITY...IT'S

GAS BOOSTER SERVICE

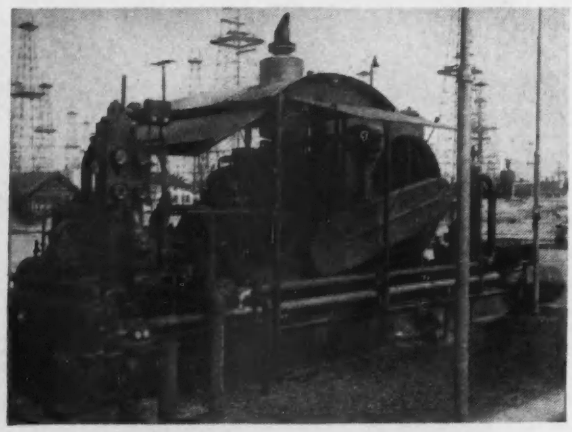


Three Clark Midget Angle 4-cylinder units, used for gas booster service at the Pacific Lighting Corporation, Wilmington, Cal.

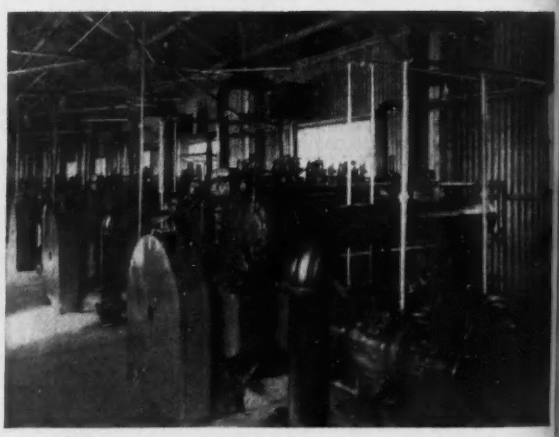


Clark Midget Angle 8-cylinder stationary units, used by the Union Oil Co., Lompoc, Cal., for gas booster service.

GATHERING FIELD GAS



Skid-mounted Midget Angle used for gathering field gas by Long Beach Oil Development, Long Beach, Cal.



Five stationary-mounted 4-cylinder Midget Angles at Consolidated Gas Utilities Company, Magic City, Texas.

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ONE OF THE DRESSER INDUSTRIES

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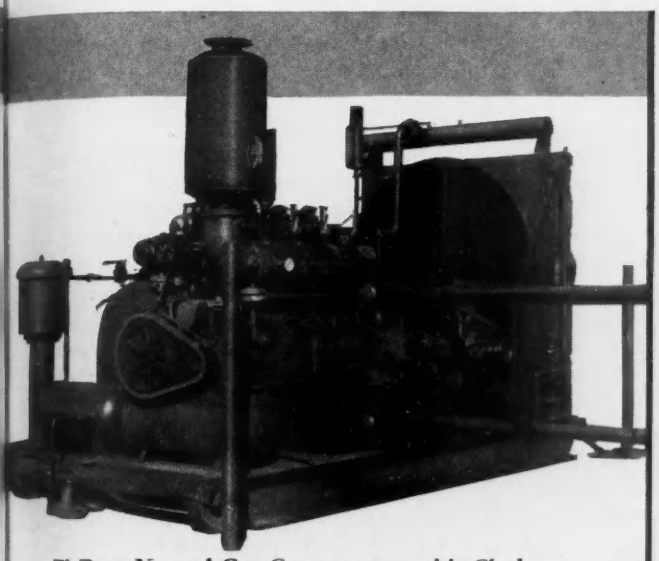
THE "MIDGET ANGLE"



El Paso Natural Gas Company uses this Clark 4-cylinder semiportable MA unit for gas booster service at Jal, N. M.

These typical installations . . . only a few of hundreds throughout the industry . . . *prove* the versatility of Clark Gas-Engine-Driven "Midget Angle" Compressors.

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Operating costs are low. Operation is practically automatic—one or two men can easily handle several stations.

Clark "Midget Angles" are available in 2, 4, 6 and 8 cylinder units, developing from 75 to 300 B.H.P. For further information call your nearest Clark Bros. office, or write for descriptive booklet.

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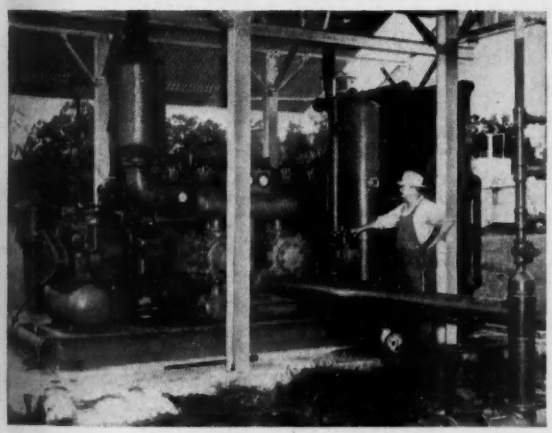
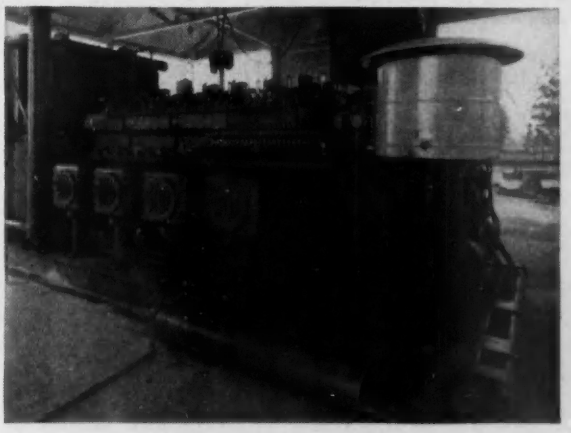
GAS LIFT



Skid-mounted Clark Midget Angle in gas lift service for the Atlantic Refining Co., Harden Field, Texas.

REPRESSURING



Two 8-cylinder Midget Angles used in repressuring residue gas back into producing sands—W. T. Burton Co., Stark, La.

ANGLE" COMPRESSORS

Midyear *Stocks* Fairly Adequate

ALTHOUGH this year has brought considerable anxiety regarding stocks of crude oil and refined products, the inventory situation was comparatively good at the middle of the year and gave promise of continuing fairly satisfactory. Through benefit of sharp curtailment of crude production and refinery runs, the industry has avoided making seriously excessive additions to stocks of crude or products. Crude oil and gasoline stocks are within desirable levels. Stocks of distillate fuel oil and kerosine appear somewhat high, but demand for those products is expected to be good and the inventories may be largely needed. Residual fuel oil stocks have been larger than necessary, but there is some improvement in the outlook for consumption of this product because of lower residual prices.

Total stocks of all oils in the U. S. at the end of June this year amounted to 635,781,000 barrels. That was equivalent to 106 days' supply on the basis of the daily average demand for all oils in the first six months of this year. It was about 112 million barrels more than the 523,906,000 barrels held at mid-year of 1948, but at that time, stocks were still around the exceptionally low levels of the post-war scarcity period, having been equivalent to only 85 days' supply at the consumption rates of last year's first six months. Stocks of all oils at mid-year of 1947 were equal to 86 days' supply, but those held at mid-year 1941 were equivalent to 131 days' supply.

50 Days' Supply

Crude stocks totaled 274,256,000 barrels at the end of June this year, equivalent to 50 days' supply. One year previously they had totaled 231,412,000 barrels, equal to only 40 days' supply. Estimates as to the maximum desirable level for U. S. crude stocks have ranged from 250 to 275 million barrels. Crude stocks currently are held in generally satisfactory amounts by districts and grades, although inventories of West Texas sour crude and various heavy crudes have been larger than desirable.

U. S. stocks of motor fuel at the end of June 1949 totaled approximately 114,048,000 barrels and were nearly 12 million barrels or 11.5 percent above the 102,298,000 barrels held at mid-year 1948. However, motor fuel demand has been running almost 7 percent higher this year than last year, and stocks at mid-year 1949 were equivalent to only 45 days' compared with 43 days' supply held a year previously.

Stocks of kerosine at the end of June this year totaled 23,530,000 barrels, equal to 83 days' supply, compared with 18,480,000 barrels or 54 days' supply held at mid-year 1948.

U. S. stocks of distillate fuel oil at refineries and bulk terminals totaled 64,148,000 barrels on June 30, 1949, equal to 67 days' supply, compared with 45,835,000 barrels or 43 days' supply a year previously. But relatively warm weather held down this year's demand, and normal weather next fall and winter would swell consumption materially, while many new oil burner installations this year will create much new demand.

Residual fuel oil stocks at U. S. refineries and terminals totaled 65,857,000 barrels at the end of June this year, equal to 47 days' supply, compared with 44,213,000 barrels or 30 days' supply held a year previously.

Stocks of Crude Petroleum in U. S. by Grades, at End of June

(Based on Weekly Reports of U. S. Bureau of Mines)

(THOUSANDS OF BARRELS)

Grade or Origin	July 3, 1948	July 2, 1949
Pennsylvania Grade	2,723	3,048
Other Appalachian	889	1,965
Lima-Michigan	892	1,116
Illinois-Indiana	10,043	13,240
Arkansas	2,745	3,022
Kansas	8,292	8,969
Louisiana	11,195	14,999
Northern Louisiana	3,101	3,384
Gulf Coast	8,094	11,615
Mississippi	2,720	3,178
New Mexico	5,246	7,642
Oklahoma	27,859	31,183
Texas	113,437	129,249
East Texas	16,290	18,272
West Texas	43,239	51,568
Gulf Coast	29,577	30,150
Other Texas	24,331	29,259
Panhandle	3,793	5,450
North	6,637	7,067
South	4,618	7,045
Other	9,283	9,687
Rocky Mountain	9,014	13,907
California, including heavy	31,045	34,651
Foreign	5,395	8,144
Total in United States	231,495	274,313

Stocks of Major Petroleum Products Held by Refining Companies in the United States at End of June, Compared with 1948

Stocks at refineries, at bulk terminals, in transit, and in pipe lines. Data from Bureau of Mines except June, 1949, from weekly reports of American Petroleum Institute

(THOUSANDS OF BARRELS)

DISTRICT	FINISHED AND UNFINISHED GASOLINE Stocks End of June		KEROSINE Stocks End of June		GASOIL AND DISTILLATE FUEL Stocks End of June		RESIDUAL FUEL OIL Stocks End of June	
	1948	1949	1948	1949	1948	1949	1948	1949
East Coast	25,325	27,287	7,723	9,777	14,533	21,507	9,621	9,902
Appalachian	3,206	3,640	516	566	781	893	505	773
District No. 1	2,223	2,533	427	404	643	695	379	497
District No. 2	983	1,107	89	162	138	198	126	276
Indiana, Illinois, Kentucky	21,399	24,809	3,190	3,921	6,378	9,850	4,820	5,397
Oklahoma, Kansas, Missouri	8,476	11,261	1,073	1,434	3,566	4,802	1,985	2,457
Texas Inland	3,439	4,246	823	570	561	827	758	1,179
Texas Gulf Coast	16,063	15,326	2,099	3,632	6,272	10,000	6,064	7,990
Louisiana Gulf Coast	4,993	5,598	1,481	2,063	3,060	4,019	1,555	2,122
North Louisiana and Arkansas	2,263	2,670	459	446	363	977	279	243
Rocky Mountain	3,065	3,160	243	335	1,099	1,497	1,071	967
District No. 3	74	58	31	25	48	74	30	29
District No. 4	2,991	3,102	212	310	1,051	1,423	1,041	938
Total East of California	88,229	97,997	17,607	22,744	36,613	54,372	26,658	31,030
California	16,289	16,493	873	786	9,222	9,776	17,555	34,827
Total United States	104,518	114,490	18,480	23,530	45,835	64,148	44,213	65,857

TYPE XFG OTIS SURFACE SAFETY VALVE

automatic flow line shut-off upstream from surface choke . . . plus dependable flow line protection downstream from surface choke

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1. Can be installed in a flow wing to provide a positive shut-off at a point *upstream* from a surface choke.

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3. When fluid is exhausted through the pilots into the flow line at a point *downstream* from the surface choke, the gate is driven down from a fully-opened to a positive closed position, thus shutting off all flow through the line.

For complete information on the new Type XFG and all other standard Otis Surface Safety Valves, write Otis Pressure Control, Inc., Box 7206, Dallas, Texas.

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OTIS PRESSURE CONTROL, INC.

SURFACE SAFETY VALVE

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U.S. Refining Operations Down This Year

U.S. refinery operations have been curtailed this year because of the lagging demand for most of the refined products except gasoline and because of the efforts to avoid accumulation of excessive stocks. On a daily average basis, total crude runs to stills were 2.5 percent lower in the first half of 1949 than in the first six months of 1948, having been off to 5,353,000 barrels daily from 5,493,000, a decrease of 140,000 barrels daily.

Refinery runs of domestic crude averaged 4,951,000 barrels daily in this year's first half, a decrease of 249,000 barrels from the 5,200,000 per day processed in the initial half of 1948. Runs of foreign crude were increased to 402,000 barrels per day from 293,000 daily last year, a gain of 109,000 daily or 37.2 percent.

The total volume of all crude run to stills in this year's first half was 968,935,000 barrels, a decrease of 30,737,000 barrels or 3.1 percent from the 999,672,000 barrels processed in the first six months of 1948, which had the extra day for Leap Year. Total amount of domestic crude charged to stills in the first half of 1949 was 896,213,000 barrels, a decrease of 50,080,000 barrels or 5.3 percent from the 946,293,000 barrels run in last year's first half.

The different refining districts have shown widely varying trends in refinery operations. Runs have been sharply lower this year than last year on the East Coast, the Texas Gulf Coast, and in inland Texas. They have been moderately lower in other districts except California and the Middle West, where increases are shown.

On the East Coast, total runs of 137,968,000 barrels in this year's first half were off 18,043,000 barrels or 11.6 percent from those of 156,011,000 barrels in last year's first six months. On the Texas Gulf Coast, runs totaled 234,962,000 barrels, a decrease of 14,085,000 barrels or 5.7 percent, from the 249,047,000 in the like period last year. For inland Texas runs of 39,639,000 barrels were 5,381,000 barrels or 12 percent less than the 45,020,000 barrels last year. In the Appalachian district, runs totaled 28,755,000 barrels compared with 30,583,000, a decrease of 6 percent.

In Oklahoma, Kansas, and Missouri, runs for the six months this year totaled 76,153,000 barrels, 5.6 percent less than the 80,691,000 last year. On the Louisiana Gulf Coast, runs totaled 76,749,000 barrels, off 1.1 percent from 77,614,000. In North Louisiana and Arkansas, runs amounted to 13,354,000 barrels or 7.2 percent less than the 14,389,000 of last year.

In California, total runs amounted to 167,007,000 barrels, an increase of 8,373,000 barrels or 5.3 percent from the 158,634,000 barrels for the first half of 1948. In the Rocky Mountain district, runs totaled 30,906,000 barrels, an increase of 1,965,000 barrels or 6.8 percent from the 28,941,000 barrels last year.

In June of 1949, U. S. crude runs to stills averaged 5,236,000 barrels daily, a decrease of 7 percent from the 5,632,000 daily recorded for June of 1948, when the industry was still in the period of all-out operations to avoid threatened shortages.

While runs have been curtailed, refinery capacity in the U. S. has been increased materially since a year ago. Consequently, plants have been operating at considerably lower percentages of capacity than at mid-year of 1948. Total capacity of U. S. plants in June of 1949 was placed at 6,340,000 barrels of crude daily, an increase of 502,000 barrels over that of 5,838,000 daily for June of last year. The actual runs of June 1949 represented utilization of 82.6 percent of U. S. capacity, whereas runs of June 1948 had been 96.5 percent of capacity.

U. S. Crude Runs to Stills and Percent of Refinery Capacity Used, by Districts, June and First 6 Months 1948, 1949

Runs from Bureau of Mines, except May and June, 1949, from American Petroleum Institute. Capacities from American Petroleum Institute

(THOUSANDS OF BARRELS)

REFINING DISTRICT	CRUDE RUNS IN JUNE: Total Amount Run			CRUDE RUNS IN JUNE: Daily Average Run		REFINING CAPACITY IN USE, JUNE: Daily Capacity		REFINING CAPACITY IN USE, JUNE: Percent Capacity Used		TOTAL AMOUNT OF CRUDE RUN TO STILLS FIRST 6 MONTHS		
	June, 1948	June, 1949	% Diff. '48-'49	June, 1948	June, 1949	June, 1948	June, 1949	June, 1948	June, 1949	Jan.-June, 1948	Jan.-June, 1949	% Diff. '48-'49
East Coast	26,936	21,179	— 21.4	898	706	830	891	108.2	79.2	156,011	137,968	— 11.6
Appalachian	4,870	4,531	— 7.0	162	151	191	193	84.8	78.2	30,583	28,755	— 6.0
District No. 1	3,106	2,844	— 8.4	103	95	123	118	83.7	80.5	18,288	16,969	— 7.2
District No. 2	1,764	1,687	— 4.4	59	56	68	75	86.8	74.7	12,295	11,786	— 4.1
Indiana, Illinois, Kentucky	26,832	26,078	— 2.8	894	869	980	1,080	91.2	80.5	158,742	163,442	+ 3.0
Oklahoma, Kansas, Missouri	14,064	12,803	— 9.0	469	427	474	500	98.9	85.4	80,691	76,153	— 5.6
Texas Inland	7,439	6,201	— 16.6	248	207	297	296	83.5	69.9	45,020	39,639	— 12.0
Texas Gulf Coast	42,165	37,727	— 10.5	1,406	1,257	1,349	1,559	104.2	80.6	249,047	234,962	— 5.7
Louisiana Gulf Coast	12,835	12,004	— 6.5	428	400	365	458	117.3	87.3	77,614	76,749	— 1.1
North Louisiana and Arkansas	2,501	2,274	— 9.1	83	76	121	96	68.6	79.2	14,389	13,354	— 7.2
Rocky Mountain	4,981	5,556	+ 11.5	166	185	190	213	87.4	86.9	28,941	30,906	+ 6.8
District No. 3	361	330	— 8.6	12	11	15	15	80.0	73.3	2,171	2,084	— 4.0
District No. 4	4,620	5,226	+ 13.1	154	174	175	198	88.0	87.9	26,770	28,822	+ 7.7
California	26,329	28,738	+ 9.1	878	958	1,041	1,054	84.3	90.9	158,634	167,007	+ 5.3
Total United States	168,952	157,091	— 7.0	5,632	5,236	5,838	6,340	96.5	82.6	999,672	968,935	— 3.1

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Footage Reflects Deep Wells

THE trend to deeper drilling has continued. Average depth of new wells completed in the U. S. in the first half of 1949 was 3636 feet, which was substantially greater than in any previous year. In the first half of last year the average depth of new wells was 3465 feet and for the whole of 1948 it was 3469 feet.

On the average, wells have been going deeper every year since 1943, when the average depth reached was 3046 feet. During the seven years 1937-43, the national average completion depth for new wells showed no great change, having varied between 3000 and 3100 feet. Prior to 1937, wells averaged less than 3000 feet in depth, the average having gradually increased from 2658 feet in 1934. Thus the past 15 years have brought an increase of about 1000 feet in the average completion depth — from about 2650 feet to almost 3650 feet.

Because of the increased depths of wells this year and a small increase over last year in number of completions, footage drilled in the first six months of 1949 was sharply higher than in the initial half of 1948. Total footage rose to 67,396,082 feet for the 18,537 new wells of this year's first half, compared with 61,558,351 feet for the 17,766 completions in the like period last year.

The 67,396,082 feet of hole drilled in new wells in the initial half of 1949 represented as much footage as for some full years in the past, when wells were shallower and annual rates of completions were lower. In 1943 there were 20,349 new wells completed with a combined footage of 61,991,857 feet. In 1942 there were 21,990 completions involving 67,903,053 feet of hole. In 1935 completions totaled 24,581 with combined footage of 67,844,939.

South Louisiana continues to lead other districts and states in deep drilling, having shown an average depth of 8522 feet for completions in the first half of this year, although that was a considerable decrease from the 9050 feet for the first six months of 1948.

Adjacent Mississippi retained second place in deep drilling. New wells there averaged 7489 feet in this year's first half, also a decrease—from 8212 feet for the initial half of 1948.

On the upper Gulf Coast of Texas, wells are comparatively deep, having averaged more than 6000 feet so far this year, as was the case last year.

In West Texas the average depth for 1358 wells completed in this year's first half was 5070 feet, compared with 4609 feet for completions in the like period last year. East Central Texas showed a decrease to 4844 feet per well from 5008.

Wells, Footage and Average Depths Drilled in U. S., by States and Districts, First Half of Year 1948-1949

STATE or DISTRICT	NEW WELLS					
	Wells		Footage		Average Depth	
	1948	1949	1948	1949	1948	1949
Alabama	7	6	34,360	33,359	4,909	5,560
Arizona	1	3	630	7,766	603	2,589
Arkansas	138	149	557,898	615,915	4,043	4,134
California	1,257	1,336	4,473,573	5,306,707	3,559	3,972
Colorado	123	28	676,838	118,739	5,503	4,241
Florida	12	9	73,140	57,731	6,095	6,415
Georgia	2	4	8,871	12,437	4,436	3,109
Illinois	1,029	1,109	2,689,683	2,776,957	2,613	2,504
Indiana	465	535	856,859	1,021,840	1,843	1,910
Iowa	....	....	....	....	....	....
Kansas	1,409	1,364	4,628,620	4,545,649	3,285	3,333
Kentucky	358	420	719,492	764,592	2,010	1,820
Louisiana	1,023	987	5,159,720	5,690,174	5,044	5,765
North Louisiana	643	524	1,720,594	1,744,441	2,676	3,329
South Louisiana	380	463	3,439,126	3,945,733	9,050	8,522
Maryland	1	....	5,259	.....	5,259	....
Michigan	310	450	720,566	1,013,035	2,324	2,251
Mississippi	192	177	1,576,764	1,325,556	8,212	7,489
Missouri	26	7	8,442	3,096	325	442
Montana	139	97	351,540	278,445	2,529	2,871
Nebraska	1	2	4,965	7,109	4,965	3,555
New Mexico	303	264	1,277,995	1,176,768	4,218	4,457
New York	852	567	1,240,700	798,634	1,456	1,409
North Carolina	....	....	.....	.....	....	....
North Dakota	....	....	.....	.....	....	....
Ohio	607	508	1,583,616	1,156,410	2,609	2,276
Oklahoma	1,870	2,019	6,684,633	7,406,437	3,575	3,668
Oregon	....	....	.....	.....	....	....
Pennsylvania	1,581	1,069	2,759,786	1,893,939	1,746	1,772
South Carolina	....	....	.....	.....	....	....
South Dakota	1	1	1,365	2,825	1,365	2,825
Tennessee	28	14	40,783	14,376	1,457	1,027
Texas	5,464	6,880	23,636,523	29,227,912	4,326	4,248
Dist. 1—South Central	228	285	737,014	841,486	3,233	2,952
Dist. 2—Middle Gulf	371	321	2,208,020	1,936,292	5,952	6,032
Dist. 3—Upper Gulf	502	659	3,344,493	4,089,470	6,662	6,206
Dist. 4—Lower Gulf-S.W.	655	711	3,243,143	3,570,284	4,951	5,021
Dist. 5—East Central	99	116	495,832	561,939	5,008	4,844
Dist. 6—Northeast	179	477	1,005,069	2,091,241	5,615	4,384
Dist. 7-B—North Central	626	949	1,970,238	2,913,407	3,147	3,070
Dist. 7-C—West Central	183	204	713,327	1,014,616	3,898	4,974
Dist. 8—West	1,345	1,358	6,198,652	6,884,672	4,609	5,070
Dist. 9—North	1,017	1,214	2,868,424	3,399,303	2,820	2,800
Dist. 10—Panhandle	259	586	852,311	1,925,202	3,291	3,285
Utah	12	25	48,272	116,523	4,023	4,661
Virginia	1	....	2,301	.....	2,301	....
Washington	2	....	11,205	.....	5,603	....
West Virginia	359	214	925,295	637,098	2,577	2,977
Wyoming	193	293	798,657	1,386,053	4,138	4,731
Total United States	17,766	18,537	61,558,351	67,396,082	3,465	3,636

Combined Footage and Average Depths Drilled in New Wells Completed in U. S.

YEAR	Wells	Footage	Average Depth
1934	21,122	56,141,433	2658
1935	24,581	67,844,939	2760
1936	28,962	80,996,816	2797
1937	35,213	105,099,189	2985
1938	29,127	90,585,158	3110
1939	28,012	85,523,094	3053
1940	31,149	96,182,605	3088
1941	32,510	99,347,714	3056
1942	21,990	67,903,053	3088
1943	20,349	61,991,857	3046
1944	25,786	84,378,457	3272
1945	26,649	92,982,113	3489
1946	30,230	101,124,813	3345
1947	33,147	112,816,124	3404
1948	38,838	134,717,379	3469
First Half:			
1948	17,766	61,558,351	3465
1949	18,537	67,396,082	3636

Wildcatting SUCCESSFUL

ALTHOUGH total well completions in the U. S. in the first half of 1949 showed only a slight increase over the like period of 1948, there was a material increase in wildcatting. Strict wildcats, seeking to open entirely new fields, totaled 3220, compared with 2707 completed in the first six months of 1948.

The 3220 wildcat completions represented 17.4 percent of the 18,537 total well completions in this year's first half, indicating an exceptionally large part of drilling devoted to wildcatting. In last year's first six months the 2707 wildcat completions were 15.2 percent of all completions, totaling 17,766. These ratios are comparatively high. In the 12 years, 1937-1948, only 12.2 percent of all wells were strict wildcats.

While wildcat completions have been numerous this year, a better than average proportion proved productive. Of the 3220 strict wildcats completed in the first six months, 13.2 percent were productive, opening 426 new fields yielding oil, condensate, or gas. In last year's first six months, out of 2707 strict wildcats completed, 11.5 percent were productive, discovering 312 new fields. The ratios of 13.2 percent of wildcats productive this year represents better success than in the long-term past. In the 12 years, 1937-1948, 11.1 percent of the strict wildcats completed were discovery wells of new fields.

Ratio of Wildcatting to All Drilling and Proportion of Wildcats Discovering New Fields, by Districts, 1948 and 1949

STATE or DISTRICT	FIRST SIX MONTHS, 1948-1949											
	Total New Wells Drilled (All Classes)		*STRICT WILDCATS									
			TOTAL				DRY		PRODUCTIVE			
			Number		Percent of All Wells				Number		Percent of All Strict Wildcats	
	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949	1948	1949
Alabama	7	6	7	6	100.0	100.0	7	6	....	....	....	....
Arizona	1	3	1	3	100.0	100.0	1	3	....	....	....	....
Arkansas	138	149	46	32	33.3	21.5	44	28	2	4	4.3	12.5
California	1,257	1,336	118	168	9.4	12.6	108	160	10	8	8.5	4.8
Colorado	123	28	25	20	20.3	71.4	25	20	....	....	....	....
Florida	12	9	9	8	75.0	88.9	9	8	....	....	....	....
Georgia	2	4	2	4	100.0	100.0	2	4	....	....	....	....
Illinois	1,029	1,109	221	249	21.5	22.5	209	242	12	7	5.4	28
Indiana	465	535	123	206	26.5	38.5	109	184	14	22	11.4	10.7
Iowa	....	....	....	....	....	....	....	....	....	....	....	....
Kansas	1,409	1,364	252	225	17.9	16.5	217	187	35	38	13.9	16.9
Kentucky	358	420	26	26	7.3	6.2	24	20	2	6	7.7	23.1
Louisiana	1,023	987	123	140	12.0	14.2	107	114	16	26	13.0	18.6
North Louisiana	643	524	56	65	8.7	12.4	51	58	5	7	8.9	10.8
South Louisiana	380	463	67	75	17.6	16.2	56	56	11	19	16.4	25.3
Maryland	1	....	1	....	100.0	....	1	....	....	....	....	....
Michigan	310	450	118	171	38.1	38.0	110	158	8	13	6.8	7.6
Mississippi	192	177	40	59	20.8	33.3	40	56	....	3	....	5.1
Missouri	26	7	3	1	11.5	14.3	3	1	....	....	....	....
Montana	139	97	16	12	11.5	12.4	15	11	1	11	6.3	8.3
Nebraska	1	2	....	2	....	100.0	....	1	....	1	....	50.0
New Mexico	303	264	38	35	12.5	13.3	30	30	8	5	21.1	14.3
New York	852	567	....	....	....	....	....	....	....	....	....	....
North Carolina	....	....	....	....	....	....	....	....	....	....	....	....
North Dakota	....	....	....	....	....	....	....	....	....	....	....	....
Ohio	607	508	19	19	3.1	3.7	18	19	1	....	5.3	....
Oklahoma	1,870	2,019	253	253	13.5	12.5	217	218	36	35	14.2	13.8
Oregon	....	....	....	....	....	....	....	....	....	....	....	....
Pennsylvania	1,581	1,069	3	2	0.2	0.2	3	1	....	1	....	50.0
South Carolina	....	....	....	....	....	....	....	....	....	....	....	....
South Dakota	1	1	1	1	100.0	100.0	1	1	....	....	....	....
Tennessee	28	14	20	11	71.4	78.6	19	10	1	1	5.0	9.1
Texas	5,464	6,880	1,190	1,492	21.8	21.7	1,036	1,248	154	244	12.9	16.4
Dist. 1—South Central	228	285	90	129	39.5	45.3	89	120	1	9	1.1	7.0
Dist. 2—Middle Gulf	371	321	107	99	28.8	30.8	94	77	13	22	12.1	22.2
Dist. 3—Upper Gulf	502	659	139	149	27.7	22.6	125	127	14	22	10.1	14.8
Dist. 4—Lower Gulf-S.W.	655	711	178	207	27.2	29.1	157	185	21	22	11.8	10.6
Dist. 5—East Central	99	116	41	39	41.4	33.6	39	37	2	2	4.9	5.1
Dist. 6—Northeast	179	477	36	41	20.1	8.6	33	33	3	8	8.3	19.5
Dist. 7-B—North Central	626	949	232	363	37.1	38.3	187	287	45	76	19.4	20.9
Dist. 7-C—West Central	183	204	52	55	28.4	27.0	45	46	7	9	13.5	16.4
Dist. 8—West	1,345	1,358	107	120	8.0	8.8	81	99	26	21	24.3	17.5
Dist. 9—North	1,017	1,214	206	285	20.3	23.5	184	234	22	51	10.7	17.9
Dist. 10—Panhandle	259	586	2	5	0.8	0.9	2	3	....	2	....	40.0
Utah	12	25	12	7	100.0	28.0	11	6	1	1	8.3	12.3
Virginia	1	....	1	....	100.0	....	....	....	1	....	100.0	....
Washington	2	....	2	....	100.0	....	2	....	....	....	....	....
West Virginia	359	214	2	5	0.6	2.3	....	1	2	4	100.0	80.0
Wyoming	193	293	35	63	18.1	21.5	27	57	8	6	22.9	9.5
Total United States	17,766	18,537	2,707	3,220	15.2	17.4	2,395	2,794	312	426	11.5	13.2

* Exclusive of all tests seeking new pay zones or outposts attempting to extend known fields.

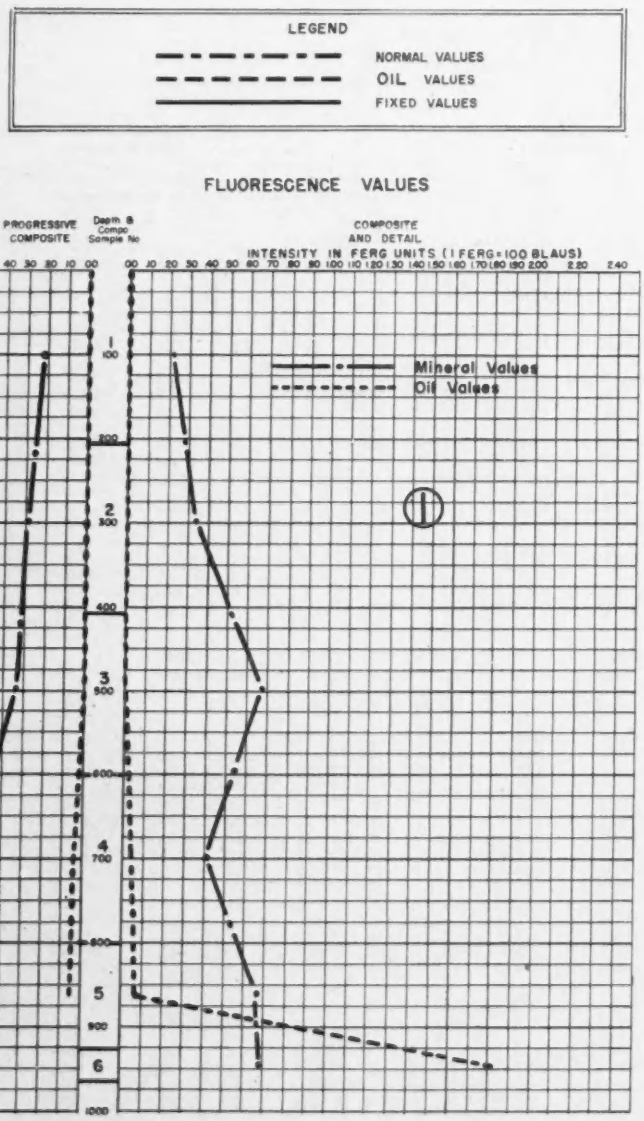
A Method of Prospecting for *Kansas "Shoestrings"*

FLUOROLOGS OF both dry holes and productive wells are significant in understanding and discovering oil accumulations of the "shoestring" type. Although exploration for Kansas shoestring fields has been largely a hit-or-miss operation, fluorologs of wells and surface exploration by fluorography can help systematize the search for shoestrings. The same prospecting methods also are effective in searching for oil accumulations of other types.

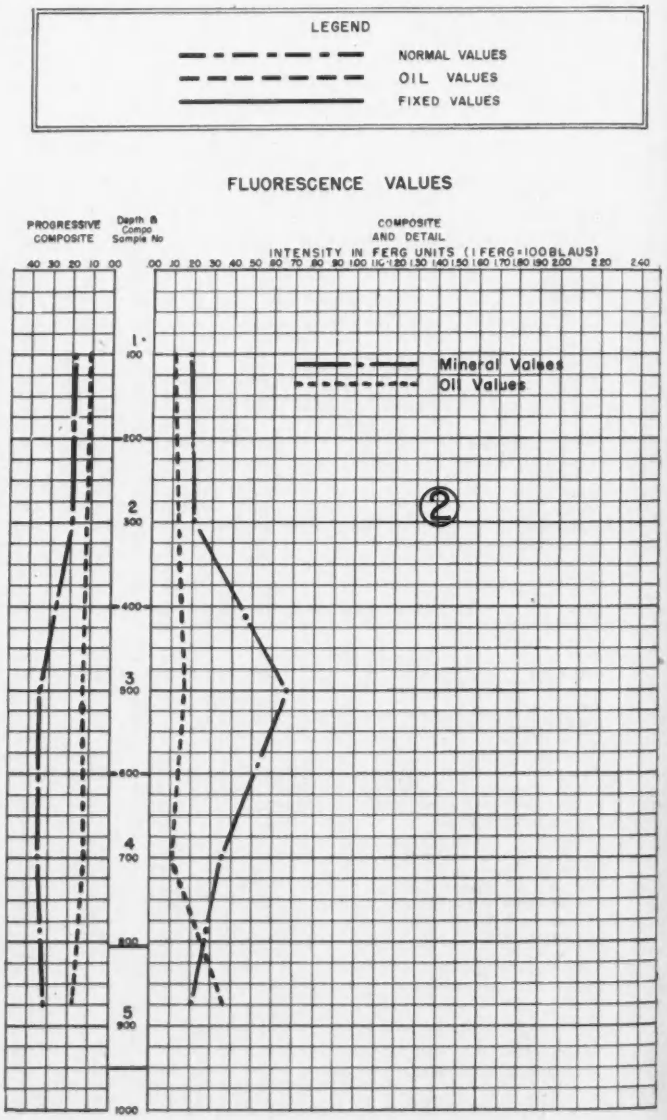
By ORTON E. CAMPBELL
Vice President, Fluorographic Exploration Company, Houston

THE fluorolog of a well, completed as a producer at 968 feet in a Kansas shoestring, showed no trace of oil above 600 feet, and only slight traces of oil between 600 feet and the pay, but the fluorolog of a dry hole, drilled just off the same shoestring, recorded traces and shows of oil from the surface to total depth of 950 feet.

This apparently contradictory situation called for an explanation. The explanation became obvious after a study of the two fluorologs, but of still greater interest is that an understanding of the dis-



FLUOROLOG 1. Completion: Oil well, total depth 968 feet. Pay zone: 927-68 feet. Anderson County, Kansas.



FLUOROLOG 2. Completion: Dry and abandoned, total depth 950 feet. Anderson County, Kansas.

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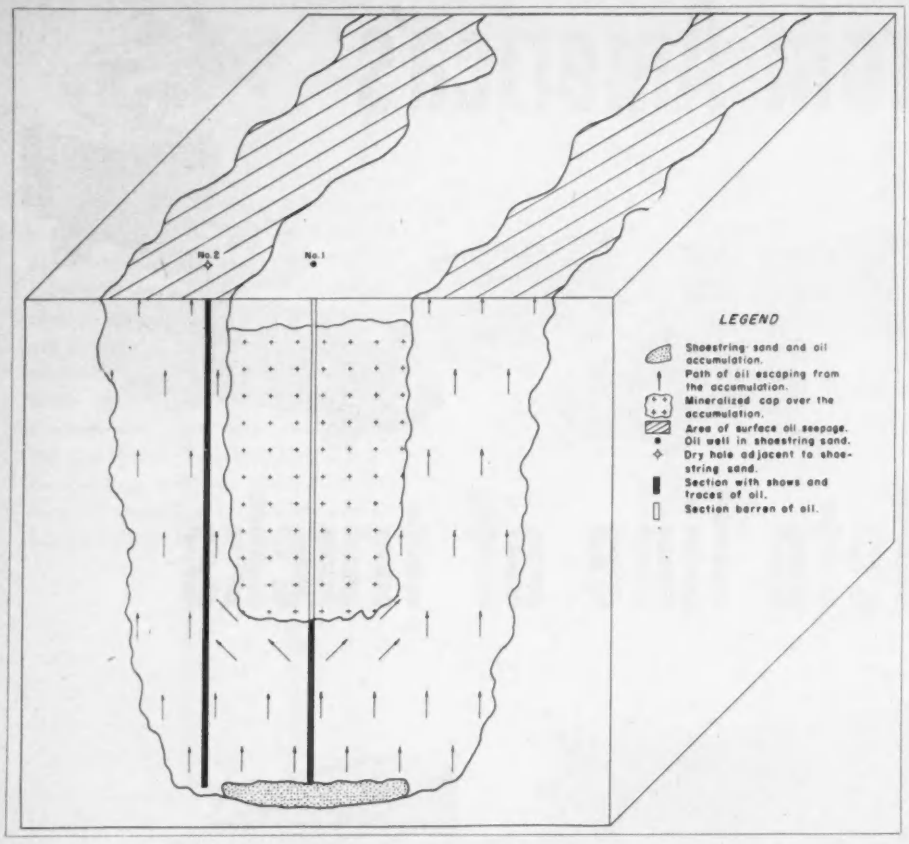

No. 2
No. 1
LEGEND
Shoestring sand and oil accumulation.
Path of oil escaping from the accumulation.
Mineralized cap over the accumulation.
Area of surface oil seepage.
Oil well in shoestring sand.
Dry hole adjacent to shoestring sand.
Section with shows and traces of oil.
Section barren of oil.

FIGURE 3. Diagrammatic illustration of a surface and sub-surface anomaly on petroleum hydrocarbons and secondary minerals across a Kansas shoestring field.

closed facts leads to a method of prospecting for shoestring oil accumulations, as well as others of stratigraphic origin.

The accompanying fluorologs are numbered 1 and 2, the first being that of the producer and the second that of the dry hole. A fluorolog is a log of the fluorescent characteristics of a geologic section. The data recorded on a fluorolog do not pertain to the quality—color—of fluorescence but to the quantity or intensity. For instance oil sands have intensities ranging from 100 to 250 blaus, ordinary shale about ten blaus, and clean sand five blaus. Fluorologs 1 and 2 show curves on oil and mineral fluorescence.

Fluorolog 1, on the producer, shows an average oil intensity of one blau from the surface to above the sand, but an average mineral intensity of 50 blaus (average curves on left side of log strip). Fluorolog 2, on the dry hole, shows an average oil intensity of 18 blaus, but an average mineral intensity of only 32 blaus.

The data recorded by the two fluorologs are shown digrammatically in the block diagram, Figure 3.

It is logical to assume that the shows and traces of oil recorded in the two wells is oil escaping upward from the shotstring accumulation. But, why does the escaping oil not reach the surface directly above the accumulation, as at location of well No. 1, while it does reach the surface on either side of it, as at location of well No. 2?

The data from the fluorologs show excess mineralization over the accumulation. Detailed analyses of this mineralization indicate that it is of secondary origin, or deposited in the rock beds after they were laid down. This type of deposition, like pouring cement in a bucket of sand, fills the pore spaces and has a sealing effect. Hence, the fluorologs indicate the presence of a plug sealed by secondary mineralization above the oil accumulation, and the presence of such a plug would explain why the oil does not escape directly upward but outward and upward. The same type of plug has been recorded above many other accumulations.

Surface Samples

The presence and general location of a shoestring accumulation can be determined from surface samples taken at a depth of four feet. But, due to the narrow and irregular course of these fields, accurate detail mapping requires shallow drill holes ten to 50 feet deep, depending upon the character of the near-surface beds. A gravel bed at the surface or just below the soil permits the surface seepage of oil to travel laterally over the area of accumulation and distort the ideal surface picture shown on the block diagram. In any case the proper procedure is to start with surface samples and follow up with shallow subsurface samples as necessary.

A dry hole drilled within one-half mile of a shoestring, if fluorologged, will show an oil curve like well No. 2. Obviously then, fluorologs on all dry holes in the shoestring country would result, in time, in a higher rate of discovery.

The use of fluorologs and fluorography — surface exploration — is in no sense limited to prospecting for shoestring fields. The discovery of Salter Pool, Butler County, Kansas, was greatly due to a fluorographic survey made after nine dry holes had been drilled on and around the structure.

But exploring for Kansas shoestring fields has always been a hit or miss operation. Hence, any method that can help systematize the search for shoestrings is of particular interest.

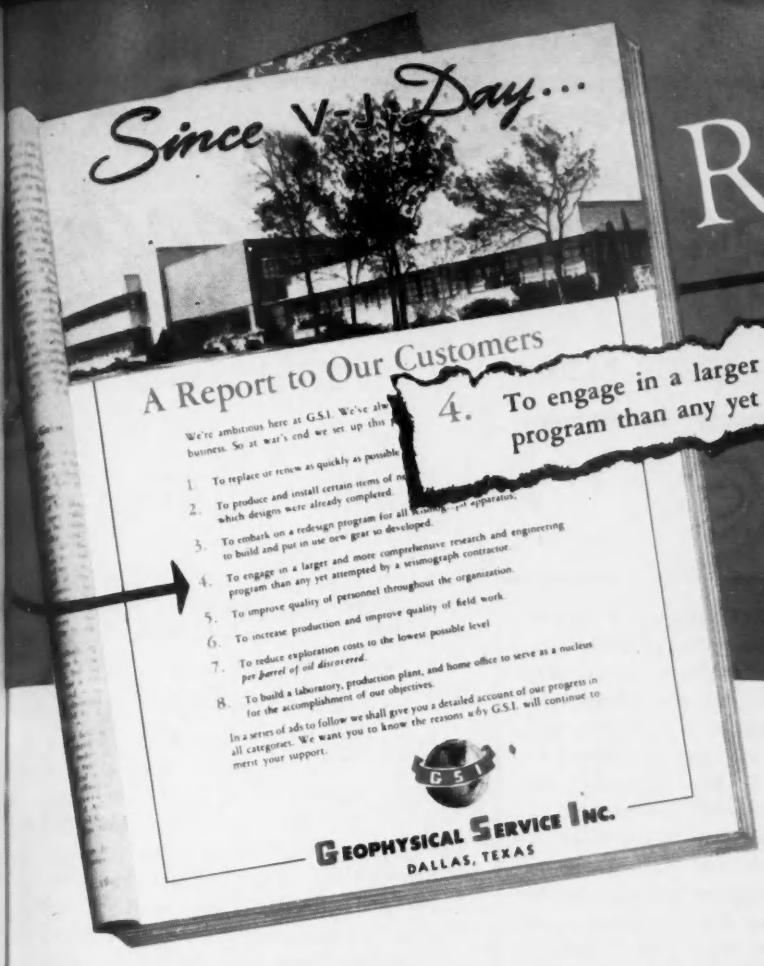
API Asks Subscriptions for Book on Secondary Recovery

Advance subscriptions are being received to defray the $17,000 cost of publication and distribution of the Second Edition of "Secondary Recovery of Oil in the United States," according to W. R. Boyd, Jr., president of the American Petroleum Institute.

API funds will finance publication of the book, provided advance orders sufficient to cover the cost of publication and distribution are received prior to placing an order for printing. Otherwise, the matter will be referred to the API Budget Committee for consideration in connection with the 1950 budget.

The first edition of "Secondary Recovery of Oil in the United States" was published in 1942, and two supplements have been issued since. The proposed second edition will contain part of the material in the original book, as well as data not previously published. The volume will have 55 chapters and approximately 650 pages. Information for the book was compiled and edited by the Standing Subcommittee on Secondary-Recovery Methods of the API Production division's Topical Committee on Production Technology.

Report No. 4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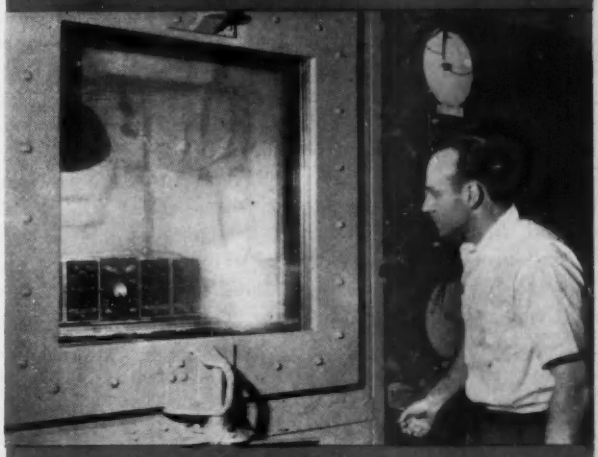

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The Greater San Juan Basin

By JOHN LEEDS KERR
Kerr & Company, Los Angeles

AMONG RECENT discoveries in the Rocky Mountain states, several in the "Four Corners" region are of particular significance, pointing to favorable oil possibilities of a "Greater San Juan Basin Area," a huge territory in Arizona, Utah, New Mexico, and Colorado. This region furnished in 1948 such important discoveries as Boundary Butte and Upper Valley in Utah and Dove Creek in Colorado. Oil and gas shows and production have been obtained from various formations, and numerous structures exist, promising future development of important production and reserves.

THE Four-Corners area of New Mexico, Colorado, Utah and Arizona has been highlighted in the oil and gas news for more than a year with a succession of discoveries and field extensions. These include the Boundary Buttes (Utah), Barker Dome (Colorado-New Mexico), Upper Valley (Utah), and Blanco (New Mexico) fields.

In this region oil and gas are produced commercially from the Pennsylvanian and Upper Cretaceous, and shows of gas have been obtained in the Devonian and Mississippian. These results, coupled with evidence of numerous structures, offer promise that the San Juan region may develop into a province of important production and reserves. The announcement of major gas pipe line developments has further intensified the interest in the area. This paper reviews the early oil history, producing formations, recent discoveries and field extensions, and the present and proposed natural gas pipe line systems from the area to markets.

This region is loosely referred to as the San Juan Basin. Technically, however, the San Juan Basin is the 12,000 square miles covering a structural area encircled by the outcropping of the Mesa Verde formation. This area is bounded on the south by the Zuni Mountains, on the east by Brazos Peak northeast of Tierra Amarilla and the Nacimiento Mountains near Cuba, on the north in Colorado by the San Juan Mountains, and on the west by the Defiance uplift in northeastern Arizona. The basin is drained primarily through the San Juan River and its tributaries.

Also contiguous to the Four Corners are the Salt basin area of southwestern Colorado, the Black Mesa basin in southeastern Utah, and the Paradox basin in central southeastern Utah. Exploratory programs of most companies in the area include the entire region and it appears that through popular usage this region contiguous to the Four Corners will be considered as the Greater San Juan Basin.

First Discoveries

Few realize that the present San Juan Basin has long been an area of oil production, there having been production in Utah in 1908, New Mexico in 1911, and Colorado in 1908. E. L. Goodrich discovered oil seeps on the San Juan River near Bluffs, Utah, in 1882, and nearly lost his life shooting the rapids of the San Juan and trying to make location for Crossing No. 1 well.

The San Juan Oil Company, of which Goodrich was an organizer, struck oil on March 4, 1908. From that date until the spring of 1909, development of the field was rapid, but in July, 1909, drilling was in progress at only one well in the entire San Juan field. There was no market for oil in this region and no means of transporting crude to the nearest refineries in California. There was little interest in the San Juan field of Utah as this was in one of the most inaccessible regions of the U. S.

The area was forgotten during World War I, but in 1921 Marland Oil (now Continental Oil Company) and other firms were actively scouting southeastern Utah. In 1923 Southwest Oil Company drilled a test at Boundary Butte, about 20 miles south of Bluff, to 1565 feet but despite a promising show of oil, the well was abandoned due to mechanical difficulties. A second well of this same company was later taken over in 1923 by Continental and Midwest Refining Company who carried it to 5612 feet. This well reported shows of gas in 12 formations and oil shows in six, with gas estimated as high as 15 million cubic feet per day.

Initial Development in New Mexico

The San Juan Basin is one of the oldest oil-producing areas in New Mexico. Oil was first discovered during 1911 in the Seven Lakes area, McKinley County. In 1921 Midwest Refining (now Stano-

About the Author

JOHN LEEDS KERR is president of Kerr & Company, Engineers, Los Angeles, which renders service to investment firms and investors, developing field research and objective reports on companies whose stocks are traded actively in the security markets. He founded the firm in 1936. He was graduated from the University of Washington and took graduate work at Sheffield Scientific School at Yale University. He is a member of the American Institute of Mining and Metallurgical Engineers, National Oil Scouts and Landmen's Association, and the Pan American Society of Petroleum Geologists.

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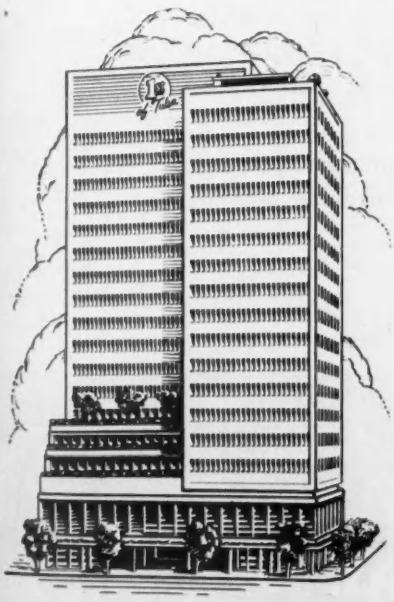
Cash and Due from Banks	$ 55,015,853.54	
U. S. Government Securities	67,397,999.79	$122,413,853.33
Other Bonds and Securities		5,848,313.25
Loans and Discounts		48,104,910.91
Federal Reserve Bank Stock		180,000.00
Income Earned, Not Collected		365,939.33
Bank Premises		1.00
Future Banking Quarters and Fixtures		1.00
Customers' Liability Under Letters of Credit		674,841.65
Other Resources		21,038.23
		$177,608,898.70

LIABILITIES

Deposits: Individuals, Firms and Corporations	$129,997,616.23	
Banks	24,344,727.54	
Public Funds	13,157,373.70	$167,499,717.47
Income Collected, Not Earned		196,082.72
Taxes, Interest and Expense—Accrued		642,703.84
Letters of Credit Outstanding		674,841.65
Capital	$ 2,000,000.00	
Surplus	4,000,000.00	
Undivided Profits and Reserves	2,595,553.02	8,595,553.02
		$177,608,898.70



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lind Oil & Gas Company) discovered gas in southern Ute Dome in the Dakota sandstone, and in 1922 found high-gravity oil in the Dakota sandstone at Hogback. Continental acquired a major interest in the Rattlesnake structure in 1924 and has since been in charge of its operation. Early in 1925 Continental completed a 750-barrel refinery at Farmington. Prior to January 1, 1942, 106 wells had been drilled to test the shallow Dakota sands, and three deep tests to the Pennsylvanian had been completed.

While there was a show of oil on the Crowley lease in 1908 in Archuleta County, Colorado, the first commercial production in the state from the San Juan Basin was in 1927 at Mancos Creek and 1935 in Gramps (Hughes) field near Price, which was owned and developed by the William E. Hughes estate at Alamosa. Over a period of years there has been considerable exploration in La Plata and Montezuma counties, Colorado. Wells were drilled at Red Mesa Dome and Dry Mesa Dome and both had a show of oil. Recent discoveries in Colorado at Dove Creek and McElmo were in previously drilled areas considered favorable for production.

Basin's Geology

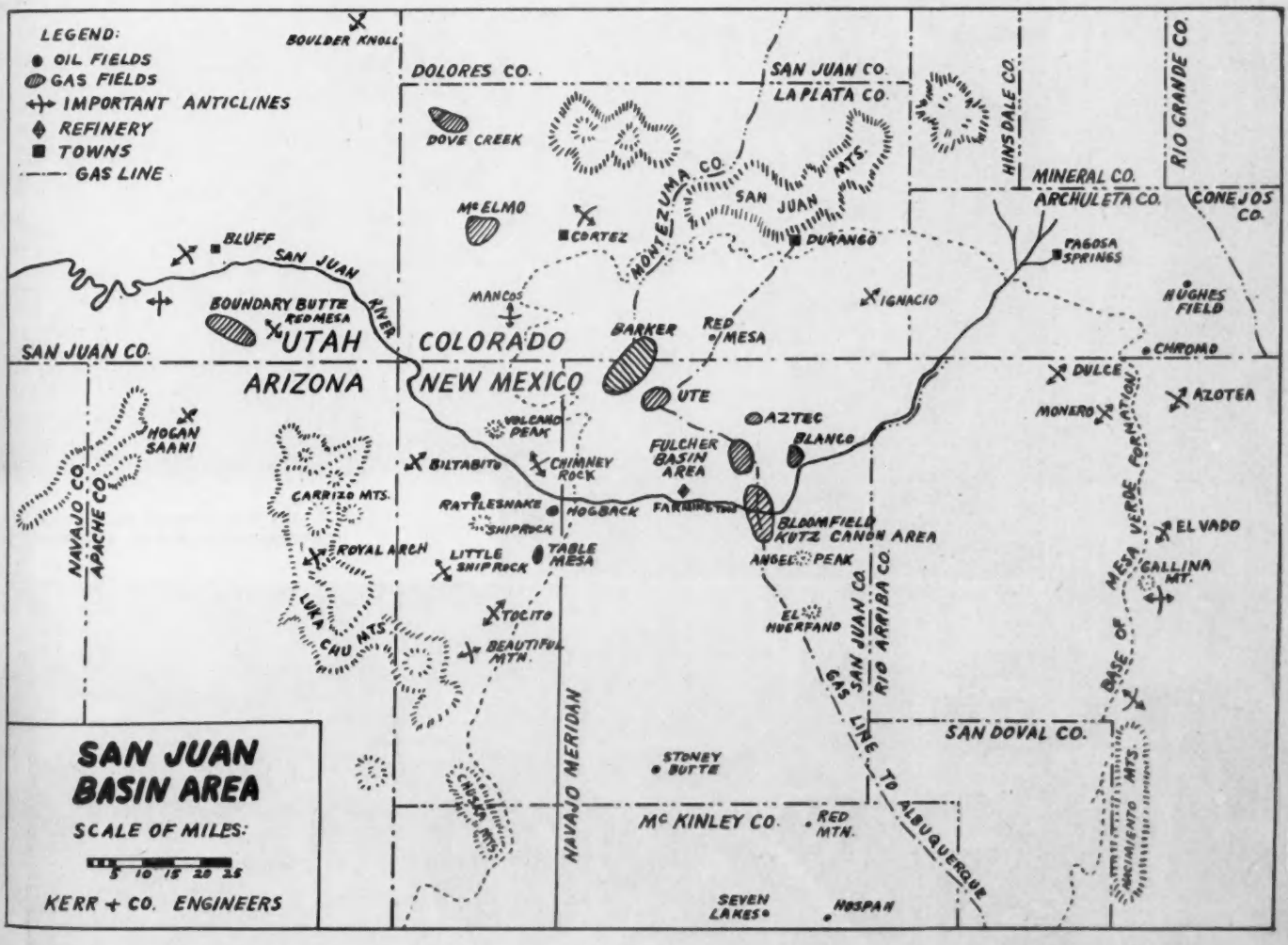
What are the major producing structures in the San Juan Basin? The rocks exposed in and around the San Juan Basin range in age from pre-Cambrian granite and schist to Tertiary sediments and volcanics. As a rule the older rocks are exposed along the outer edges of the basin, faulted and upturned against the mountains. The northern two-thirds of the basin approaches the ideal concept of a simple structural basin.

The central part of the basin in New Mexico is floored with Eocene beds. Surrounding them are strata ranging in age from Cretaceous to Pennsylvanian. It is estimated that in the deepest part of the basin the total thickness of sediments is between 12,000 and 15,000 feet as revealed by the wells drilled across the basin from east to west, approximately through the town of Farmington. The formations in the heart of the Basin are relatively flat, with beds of the Mesa Verde formation abruptly upturned on both the eastern and western edges. Beyond the outcrop of the Mesa Verde on both the east and west sides of the Basin are 1, 2, or 3 lines of gentle folds.

Thus far, oil and gas have been produced in commercial quantities only from the Pennsylvanian and Upper Cretaceous. However, there have been encouraging shows in other groups that might produce under proper conditions. At Rattlesnake and Tocito Dome, New Mexico, there have been strong shows of gas reported from the Ouray-Leadville limestone sequence of Devonian and Mississippian age.

In the San Juan Basin the principal oil-producing formation to date has been the Dakota. The oil from this sandstone has the unusually high gravity of from 55 to 76 degrees API. The Pennsylvanian oil production has been from the Rattlesnake Dome, which until recently is the only such production in the basin. Major gas-producing horizon was the Pictured Cliffs sandstone of the Cretaceous prior to 1945 and the Dakota production from the Southern Ute Dome. There was also the proved Dakota gas reserve on the Barker Dome.

The Rattlesnake production of Continental Oil Company was the only deep production in the area in prewar years, and had a three-fold productive section:



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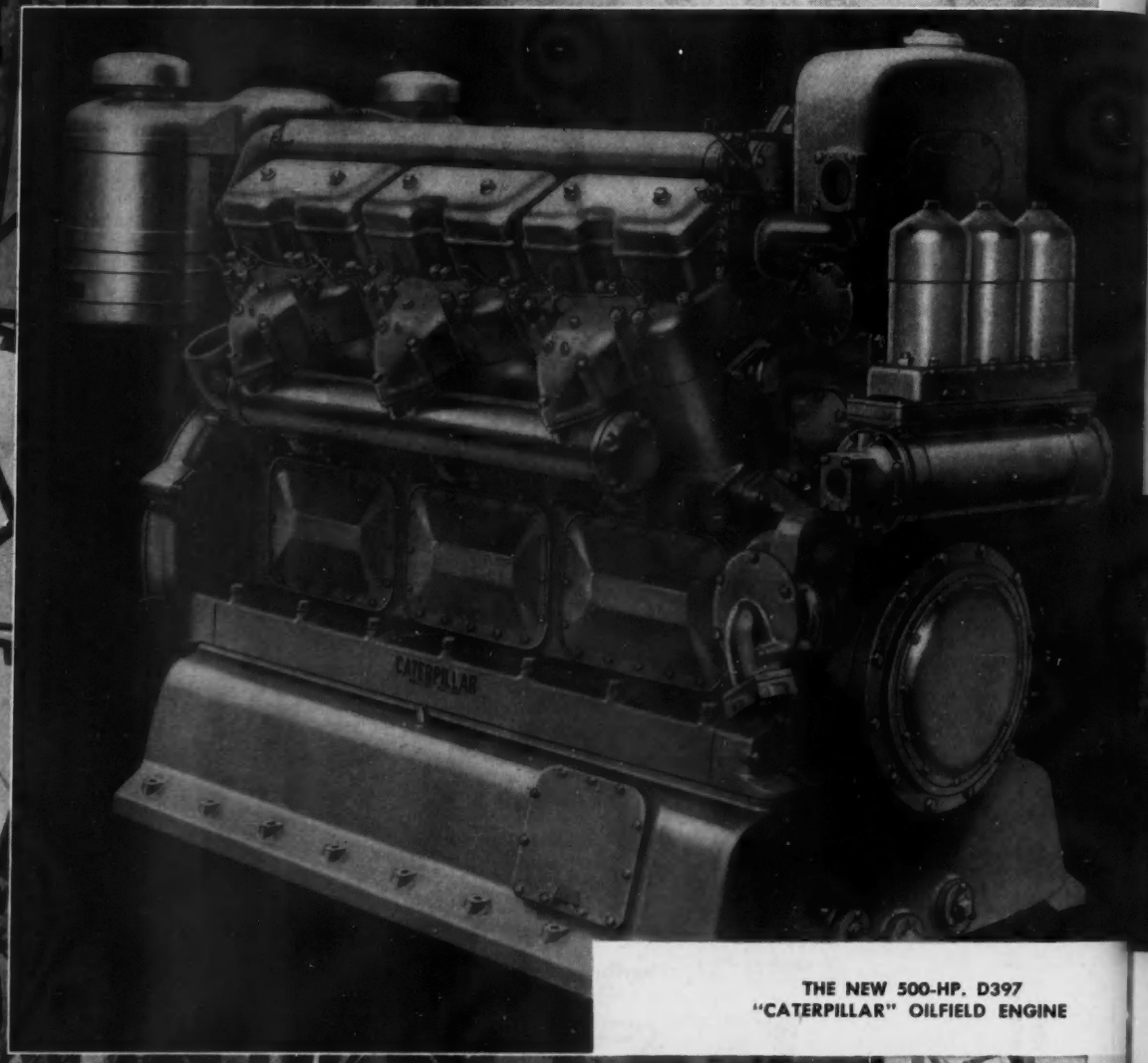

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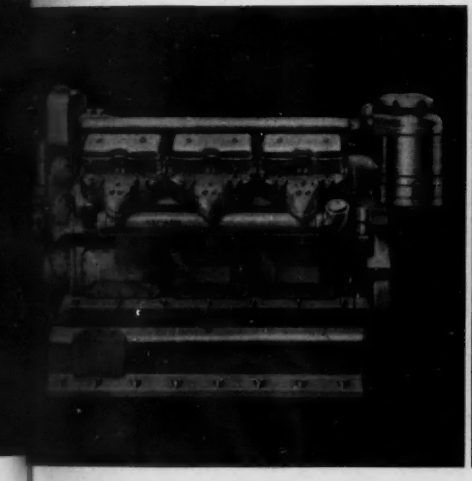

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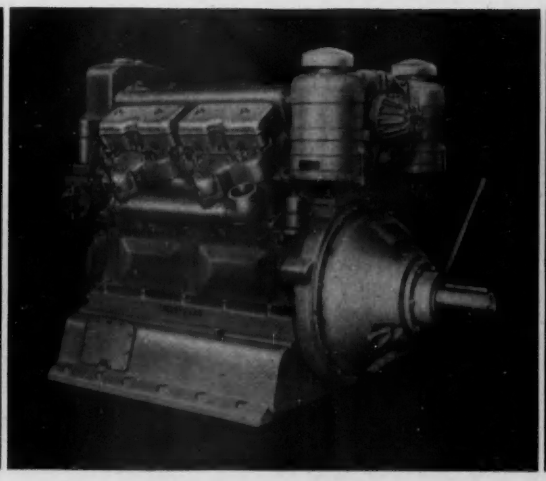

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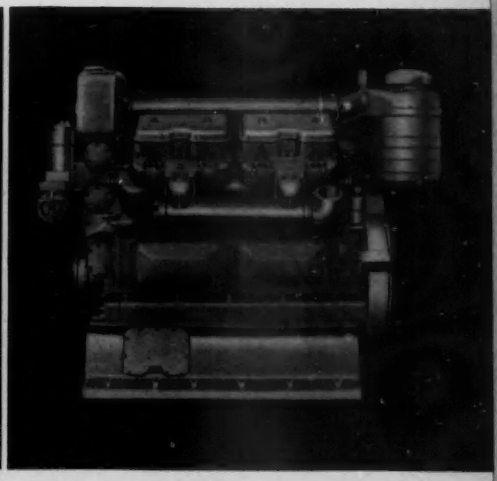

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oil from the Dakota sandstone, and Hermosa limestone, and gas from the Ouray-Leadville limestone sequence (Mississippian and Upper Devonian) with a high content of helium. Prominent features in the area are volcanic plugs, dikes and flows. One of these, Shiprock, is a topographic feature of the district and can be seen for miles on the approach from the Gallup highway.

High Gravity Crude

Oil from the Dakota is light amber-colored as it comes from the well. That oil with a gravity as high as 76 quickly weathers to 60 to 63. Difficulties were experienced when Rattlesnake crude was first sent through the pipe line to Gallup (later abandoned). As the Shiprock region is quite arid, atmospheric and ground-surface temperatures in the summer months are high. Because of the extremely high gravity and volatile nature of the oil, it vaporized as soon as it entered the warm pipe line to such an extent that it was almost impossible to pump it through the line or to flow it by gravity. Gas from the oil collected in pockets at high points, and the line became gas locked.

Production of commercial oil has been for the most part obtained from anticlines or domes although there has been some gas and a little oil from stratigraphic traps. Bates in his "Oil and Gas Resources of New Mexico," 1942, states that there are 17 fields or areas that have produced oil or gas within the New Mexico portions of the basin. Four of these have been abandoned or are negligible producers. Out of a total of 17 there are ten anticlines or domes and the remainder are stratigraphic traps. There are 75 to 80 known structures, of which 13 are now producing oil or gas; about 25 have never been drilled and not more than one-half of those tested have been drilled to the limit of possible production.

The same thing is true of the three counties in southeastern Colorado; Montezuma, LaPlata and Archuleta, where out of some 40 structures only Mancos Creek, McElmo and Dove Creek have been drilled for successful production. Far to the west in the area within a radius of 70 miles from the juncture of the Colorado and San Juan rivers, the only structures that are productive to date (with the exception of the recent Standard Oil Company of California discovery at Upper Valley, Utah), were successfully tested many years ago. There are many promising structures in Utah which deserve a test. Most geologists familiar with the area believe the southeast quarter of Utah, sometimes called the Paradox Basin, is the most likely to yield oil in paying quantities.

Oil men had never been impressed with the volume of oil production obtained from wells in the Dakota, and eminent geologists had long been of the opinion that most of the Dakota sand in the Rocky Mountain region was flushed of its oil and gas by migrating underground waters. Robert L. Bates, in an article entitled "Future Oil Possibilities of New Mexico," agrees with this thesis in part but says that it does not take into account commercial accumulations in the southern part of the Basin as at Hospah Dome. Bates is the author of an interesting bibliography on the San Juan Basin published in 1948. There is plenty of good evidence that further productive Dakota areas will be found and for that matter it is the Pennsylvanian that is now creating so much interest because of the unusually successfully discoveries of 1947 and 1948.

Discovery at Barker Dome

Southern Union Gas Company played a very important part in developing gas reserves in the area during the 1930's and obtained a lease from the Ute Indians on 4960 acres at Barker Dome in November, 1941, with the intention of developing the Dakota sand which had been found prolific in 1925 by Gypsy Oil Company. Southern Union obtained the discovery well at Barker Dome in January, 1942, and initial production was from the Dakota at 2500 feet with a flow of 15 million cubic feet daily. Activity lagged during the war period, but in April, 1945, a subsidiary of Southern Union discovered gas in the Pennsylvanian at a depth of 8500 feet. Initial production was 42 million cubic feet.

In April 1947, Barker Dome Oil & Gas brought in a 74,800,000 cubic foot well at Barker Dome in New Mexico from a total depth of 9265 feet and in October, 1948, a well across the boundary in La Plata County, Colorado, was completed by Delhi Oil, Southern Union Gas Company subsidiary, for 113 million cubic feet through a one-inch choke at the 9000-foot level. The most recent completion is Barker-Ute 19, which flowed on test at rate of 72 million cubic feet per day.

Barker Dome field is controlled by Delhi Oil and Southern Union Gas Company. Reserves are estimated at 1.776 trillion cubic feet by independent

Greater San Juan Basin Fields

SYSTEM	Formation	Oil or Gas	Field	Year Discov.	Limits of Pay Zone	Remarks
Upper Cretaceous..	Kirtland	Oil-Gas	Aztec, N. M.	1924	719–1455	57° Gravity
	Kirtland	Gas	Blanco, N. M.	1927	1650–1892	1948 test of Mancos
	Pictured Cliffs	Gas	Blanco, N. M.	1927	2220–2245	Stratigraphic trap
		Gas	Fulcher Basin, N. M.	1934	1641–2185	
		Gas	Kutz Canon, N. M.	1927	1596–2063	1 gal. per mcf nat. gasoline
	Mesa Verde Group....	Oil	Hospah, N. M.	1927	1500–1700	30° Gravity
	(Cliff House-Menefee-Pt. Lookout)	Oil	Red Mtn., N. M.	1934	430– 500	40° Gravity
		Gas	Blanco, N. M.	1927	4152–4157	
		Gas	Kutz Canon, N. M.	1947	4700	65° Gravity
		Gas	Blanco, N. M.	1949	5126	1 P 20,000 c.f.
	Mancos					Some oil shows
Upper Cretaceous..	Dakota	Oil	Hughes, Colo.	1935	1050–1400	32° Gravity
		Oil	Hogback, N. M.	1922	650– 800	60° Gravity
		Oil	Rattlesnake, N. M.	1924	700– 900	76° Gravity
		Oil	Table Mesa, N. M.	1924	1300–1500	56° Gravity
		Gas	Barker Creek, N. M.	1942	2165–3345	1 P 15,000,000 c.f.
		Gas	Ute Dome, N. M.	1921	2190–2428	Adjoins Barker Creek
		Gas Dist.	Kuts Canon, N. M.	1948	6475	51.8° Gravity
Jurassic	Morrison	Oil	Hughes, Colo.	1939	1273–1400	
	Navajo					
	Kayenta					
	Entrada-Wingate					
Triassic	Chinle					
	Shinarump	Gas	McElmo, Colo.	1948	1515–1540	1 P 500,000 cu. ft.
	Moenkopi					
Permian	Coconino-Cutler	Oil	Boundary Butte, Utah	1948	1490–1514	42.7° Gravity
Pennsylvanian	Hermosa	Gas	Boundary Butte, Utah	1948	5610–5660	1 P 28,000,000 c.f.
		Gas	Ute No. 4, N. M.	1948	8602	1 P 9,000,000 c.f.
		Oil	Rattlesnake, N. M.	1929	6585–6720	Mech. Difficulties
		Oil	Upper Valley, Utah	1948	8777–8791	17° Gravity
	Paradox	Gas	Barker Creek, N. M.	1945	8396–8875	1 P 42,000,000 c.f.
		Gas Dist.	Dove Creek, Colo.	1948	5910–5934	Important Discovery
		Gas	Green River, Utah	1948	5645	Show in Paradox
Mississippian		Gas	Cove Creek, Colo.	1948	8286	CO_2 Unimportant Zone
		Gas	McElmo, Colo.	1948	6915–6935	I P 30 mil. 82½% CO_2
		Gas	Rattlesnake, N. M.	1942	7000–7200	7.6% Helium
Devonian	Ouray	Gas	McElmo, Colo.	1948	7000–7020	Gas show

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geologists retained by Delhi Oil. Private estimates by expert natural gas engineers place reserves at from 2 to 2½ trillion cubic feet.

In any event, Barker Creek Dome is one of the largest natural gas reserves in the U. S. The proven area of the field covers about 14,000 acres. Of this area Delhi has about 12,400 acres of deep rights and Southern Union 1280 acres of deep rights plus 800 acres of both shallow and deep rights owned through its subsidiary along with 9860 acres of shallow rights. Barker Dome has a structural closure of at least 300 feet with 19 or 20 square miles within the closing contour. The producing section ranges from 30 to 175 feet.

Fulcher Basin—Kutz Canyon

Travelling about ten miles east from Farmington along the San Juan River the southern end of the Fulcher Basin field is encountered. The field extends northwest to the Animas River. There are 49 wells in the field of which Southern Union owns 26. The gas produced is from the Pictured Cliffs formation at an average depth of 1700 feet. The average thickness of pay zone is around 30 feet. The Fulcher Basin field is only about three miles from Kutz Canyon. The Dakota sand would probably be about 6400 feet and the Pennsylvanian over 12,000—13,000 feet. The Pictured Cliff sand is the only present producing section. The field is stratigraphic trap similar to Kutz Canyon on the southeast. In time, both fields will probably be joined as there is only an undrilled gap of a little more than two miles between them. Southern Union Gas is the dominant company at Fulcher Basin.

A few miles beyond Fulcher Basin is the town of Bloomfield. The Kutz Canyon field starts on the south side of the San Juan River and extends south about five miles. Acreage is owned by Western Natural Gas Company, Byrd-Frost, Inc., Stanolind, and Kutz Canyon Oil & Gas Company. There are three known producing horizons: (1) Pictured Cliff sands found at about 2000 feet with reserves of about 300 billion cubic feet; (2) gas shows have been found in the Mesa Verde; and (3) gas-condensate in the Dakota at 6500 feet. There is about 20 feet of section in the Mesa Verde. Byrd-Frost and Western Natural proved the Dakota sand by drilling a well to about 6500 feet.

Pennsylvanian Discoveries

As stated herein, the Rattlesnake was the only producer from the Pennsylvanian horizon in the San Juan Basin until 1945. Then came the Barker Creek discoveries of 1945 and 1947. This was followed by new Pennsylvanian discoveries at Dove Creek, Colorado; Boundary Butte, Utah; McElmo, Colorado and Upper Valley, Utah. At Dove Creek, Colorado, in 1948, Byrd-Frost and Western Natural Gas chalked up a new Pennsylvanian discovery from the Paradox sand which on test produced from 200 to 1000 barrels of 64-gravity condensate plus 20 million cubic feet of gas. This discovery is 25 miles northwest of Cortez, Colo., and 55 miles northwest of Barker Dome. The White 1 well, about three-quarter mile from the discovery well, has been disappointing and has been temporarily abandoned.

At McElmo, Colorado, Western Natural brought in a gasser with production at 30 million cubic feet at 6915-35 feet in the Mississippian and a second well had a show of 500,000 cubic feet in the Shinarump at 1515 feet. The first 20th Century commercial discovery of oil in Utah was near Vernal in 1948, and the second, Western Natural Gas—Byrd-Frost's English 1, at Boundary Butte. Western Natural has a one-half interest in about 11,000 acres covering the Boundary Butte structure. The second well, English 2, is 2½ miles from No. 1. The first well on open flow showed 25 million cubic feet per day from the Hermosa, while the second tested 9 million. In addition to gas in the Pennsylvanian, at about 5610 feet, the English 2 well has obtained commercial production of high-gravity oil at the rate of 100 barrels per day from the Conconino sandstone at 1514 feet. The latest completion at Boundary Butte is English 4, which hit the top of Coconino sandstone at 1608 feet and is pumping 75 barrels.

With ten wells or more, the company plans to maintain output of 30 million cubic feet per day. This will be delivered to a new concern, the San Juan Pipeline Company. The Boundary Butte area is one of great promise. Stanzona Oil Company of Arizona has applied to Utah for 46,000 acres of leases on school properties entirely surrounded by reservation lands. Southern Union, Standard Oil Company of California and others have acreage under lease in southeastern Utah, part of the San Juan Basin, and General Petroleum is drilling in Arizona near Carrizo. At year-end 1947, Western Natural Gas had one-quarter interest in 79,000 acres, a one-half interest in 242,600 acres and full interest in 38,800 acres in San Juan Basin. Holdings are much greater today.

A subsidiary of California Standard discovered oil in the Kaiparowitz Plateau area of Utah at a point about 50 miles northwest of the juncture of the San Juan and Colorado rivers. This was Utah's third commercial oil well and bottomed at 8791 feet in the Hermosa and swabbed 130 barrels of 17-gravity oil in 16 hours and 142 barrels of oil in 19 hours on packer test. The oil is from 14 feet of fractured lime pay in the Hermosa between 8777-971 feet. Subsequently testing has been more encouraging.

Outlets for Natural Gas

The major outlet for natural gas in the San Juan Basin has been through the transmission lines of Southern Union Gas Company, which has a line from Barker Creek Dome and other fields in the general area to Albuquerque. There is also a six-inch line from the Ute Dome to Durango, Colo. Otherwise there are no pipe line transmission lines in the area and few communities with sufficient population to consume any appreciable amount of gas. In fact, within a radius of 100 miles from the Four Corners the population is probably only a little over 10,000 excluding Ute and Navajo Indians on reservations.

However, there is a new emphasis on natural gas in Rocky Mountain and Pacific states. Southern Union will require huge amounts of gas for its local system in New Mexico and additional amounts to serve cities along the Santa Fe Railroad in northern Arizona. During the next 25 years atomic energy plants at Los Alamos will require 500 billion cubic feet of gas according to testimony of AEC executives. El Paso Natural Gas, through a wholly owned subsidiary, San Juan Pipeline Company, plans to construct a 451-mile line from San Juan to Needles, Calif., where P. G. & E. will transport the gas via a new line to northern California.

Texas gas is already being transported to Southern California by El Paso Natural Gas Company via Blythe, a small city on the Colorado River about 100 miles south of Needles. In view of the huge increase in population and industrial growth in California, additional natural gas supplies are imperative as local gas reserves cannot meet existing requirements. Army and Navy installations in California are also dependent on natural gas.

Byrd-Frost has been planning a pipe line from the San Juan Basin to San Francisco and Seattle via Salt Lake City. The proposed Byrd-Frost line would probably serve the Boundary Butte wells in San Juan County, Utah, thence directly north to Green River, where Amerada Petroleum Corporation's recent discovery had a show of gas in the Pennsylvanian, and thence to Salt Lake and San Francisco.

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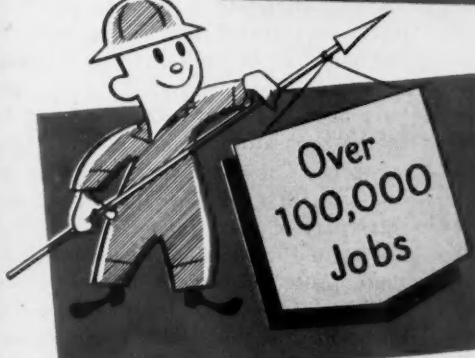

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LANE-WELLS SERVICE AND PRODUCTS ARE AVAILABLE THRU PETRO-TECH SERVICE CO. IN VENEZUELA

The California Company's Bay Marchand Field

By J. E. KASTROP
Staff Writer

WITH the highest batting average of any offshore operator to date (two dry holes against seven good oil wells), The California Company is in the midst of an accelerated development program that promises to produce the most outstanding oil field yet discovered on the Continental Shelf. The Bay Marchand field is only four miles off the coast of LaFourche Parish, Louisiana, in about 30-35 feet of water. Productive limits of the field have not been defined, but seven good oil wells have been completed in producing horizons ranging from 2873 to 5100 feet. Within this relatively shallow range, four producing horizons have been encountered, producing oil ranging from 20.1 to 40.9 gravity, with no evidence of water. Current productive limits of the field are confined to Louisiana State Leases 1366 and 1367. Allowable on five of the seven producers is 879 barrels per day. (Allowables for latest two completed wells not granted at this writing.)

The California Company spudded its first Bay Marchand well, the Louisiana State No. 1, in Lease 1367, Block 3, on January 9. The well found the top of the salt dome at only 2131 feet and the location was abandoned, but the structure was left intact to serve as a separator platform for later wells.

The company's second well, the No. 1 Louisiana State Lease 1366, Block 2, discovered the Bay Marchand field on March 7, 1949. It was drilled to only 3721 feet, and 5½-inch casing was cemented to 3700 feet. The well was perforated with 110 shots from 2873-92 feet. Initial production was 255 barrels of clean 26.7-gravity oil per day on a one-half-inch choke. Tubing pressure gauged 80 pounds, with gas-oil ratio at 303 to 1.

Three additional wells have been completed from this structure, totalling four producers. A fifth well is currently drilling from the platform. When completed, the rig and tender will move to a double structure designed to accommodate ten field wells. A third offshore platform (including the first abandoned structure) contains three producing wells, with a fourth now drilling. A dry hole was drilled from this platform, making the second duster in the field.

Drilling operations have been conducted from the tried-and-proven platform-floating tender combination. A small double-deck platform mounted on heavy steel piling supports the drilling rig. Converted LSTs serve as drilling tenders. Drilling rigs and crews were furnished by the Noble Drilling Corporation, while The California Company provided the platforms, drilling tenders and marine transportation.

ABOVE: Looking eastward across the separator platform in the Bay Marchand field. This structure served to drill the first dry hole here. The rig in the background is currently drilling the fifth well on that structure.

The original platform from which the first dry hole was drilled now serves as a separator platform for wells producing oil. In addition to separators, the platform pictured above supports two 500-barrel stock tanks, pipe line pumps, manifolds and doghouse. Flow lines have been laid from each producing well to the separator platform where the oil is stored. The company laid a four-inch line, the first offshore pipe line, from the separator platform to a barge terminal located inside Pass Fourshon. Inside these protected waters, barges take on oil which is pumped from the separator platform. The doghouse on the platform provides protection to a pumper who remains on the structure at all times.

The relatively short distance from the company's headquarters at Grand Isle and shallow producing horizons make the Bay Marchand field the most outstanding development thus far discovered in the open waters of the Gulf. While its reserve is not yet known, those who are familiar with Bay Marchand feel that in the light of relatively small development costs (when compared to other offshore operations) this field will pay out in a reasonable length of time.

Dr. F. M. Kannenstine, of Kannenstine Laboratories, has been designing seismograph instruments for 23 years. The Kannenstine Laboratories is an affiliate of Independent Exploration Co., where Dr. Kannenstine and his staff of scientists and technicians carry on continuous research to improve Independent's instruments as to sensitivity, fieldworthiness, and development of record character.

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At High Level in June

THIS year's exploratory drilling continued high during June as completions equalled the all-time mark set in the previous month. While June could only tie the total number of wells, it far outdistanced other periods in the number of productive tests.

A total of 680 exploration wells were completed during the month, of which 164 were rated as commercial producers for a score of 24.1 percent of the total. In May the same number of tests had yielded 120 producers which amounted to 17.6 percent.

The previous high exploratory drilling month had been July, 1948, with 677 tests completed, of which 20.8 percent or 141 wells found production. June's activity helped give the year's first half a lead of 18.5 percent over last year's exploratory drilling.

The month's operations accounted for 109 new crude pools. These being 69 new fields and 40 new pay horizons in established fields. May had contributed 50 new fields and 27 new crude producing strata.

Summary of Results of Exploratory Drilling

ITEM	June, 1949	May, 1949	SIX MONTHS: January-June 1949	1948	Percent Diff.
Oil Discoveries	109	77	495	405	+ 22.2
New Fields	69	50	332	246	+ 35.0
New Pays	40	27	163	159	+ 2.5
Distillate Discoveries	13	16	77	45	+ 71.1
New Fields	3	10	38	24	+ 58.3
New Pays	10	6	39	21	+ 85.7
Gas Discoveries	16	7	69	60	+ 15.0
New Fields	14	5	56	42	+ 33.3
New Pays	2	2	13	18	— 27.8
Total Discoveries	138	100	641	510	+ 25.7
Extension to Fields	26	20	133	93	+ 43.0
Oil Fields	22	18	118	74	+ 59.5
Distillate Fields	3	2	10	8	+ 25.0
Gas Fields	1	.....	5	11	— 54.5
Total Prod. Tests	164	120	774	603	+ 28.4
Dry Holes	516	560	2828	2436	+ 16.1
Wildcats	507	553	2794	2396	+ 16.6
New Pays	.....	.....	2	7	— 71.4
Outposts	9	7	32	33	— 3.0
Total Expl'tory Tests	680	680	3602	3039	+ 18.5
Percent Productive	24.1	17.6	21.5	19.8	.....
Percent Dry	75.9	82.4	78.5	80.2	.....

Results of Exploratory Drilling in June and First 6 Months, 1949-1948, by Districts

State or District	MONTH OF JUNE, 1949													FIRST SIX MONTHS, 1949																	
	Productive Tests									Total Productive	Unproductive Tests			Total Exploratory Tests	Productive Tests								Total Productive		Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions								New Fields			New Pays			Extensions									
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis	Gas	6 Mo. 1949	6 Mo. 1948	Wildcats	New Pays	Outposts	6 Mo. 1949	6 Mo. 1948	6 Mo. 1949	6 Mo. 1948
Alabama																										6			6	8	6	8
Arizona																										3			3	1	3	1
Arkansas	1		1							2	10		1	13	3		1	2						6	2	28		1	29	44	35	46
California			1	3			1			5	48			53	6		2	8			9		1	26	30	160		1	161	108	187	138
Colorado											3			3												20		1	21	25	21	25
Florida											1			1												8			8	9	8	9
Georgia																										4			4	2	4	2
Illinois	3			5			4			12	53			65	7			14			25			46	40	242			242	209	288	249
Indiana	4									4	25			29	22			3			4			29	19	184			184	109	213	128
Iowa																																
Kansas	10		1	3						14	36			50	35		3	4			3			45	38	187			187	218	232	256
Kentucky	3									3	6			9	6									6	4	20			20	24	26	28
Louisiana	1	2	1	5						9	23			32	15	7	4	16	12	1	4	1		60	56	114			114	108	174	164
North Louisiana		1		1						2	14			16	3	3	1	1	7					15	10	58			58	51	73	61
South Louisiana	1	1	1	4						7	9			16	12	4	3	15	5	1	4	1		45	46	56			56	57	101	103
Maryland																													1		1	
Michigan	4									4	22			26	12		1				5			18	9	158		1	159	110	177	119
Mississippi				1						1	9		2	12	3			2						5	2	56		2	58	41	63	47
Missouri																										1			1	3	1	3
Montana											2			2	1									1	3	11		1	12	15	13	18
Nebraska	1									1	1			2	1									1		1			1		2	
Nevada																																
New Mexico											6			6	5			3						8	13	30			30	30	38	43
New York																																
North Carolina																																
Ohio											1			1							2		3	3	9	19			19	18	22	27
Oklahoma	10		2	1			5			18	31			49	29	2	4	8	1	2	14			60	55	218			218	218	278	273
Oregon																																
Pennsylvania																	1							1		1			1	3	2	3
South Dakota											1			1												1			1	1	1	1
Tennessee															1									1	1	10			10	19	11	20
Texas	30	1	8	18	10	2	11	3	1	84	218		6	308	179	29	36	94	26	10	46	9	3	432	297	1248	2	22	1272	1070	1704	1367
Dist. 1 S. Central	2			1						3	15		1	19	9			1			1			11	3	120		1	121	89	132	92
Dist. 2 Middle Gulf	1		1		4	1		1	1	9	13		1	23	4	11	7	5	5	3	1	3	1	40	39	77		4	81	100	121	139
Dist. 3 Upper Gulf	2		1	9	3		1	1		17	18			35	10	10	2	30	11	2	4	3		72	51	127			127	129	199	180
Dist. 4 L. Gulf-SW	2		3	2	3	1	1			12	24		1	37	8	5	9	25	8	5	1	1		62	50	185	1	6	192	170	254	220
Dist. 5 E. Central	1									1	3			4	1	1						1		3	5	37			37	39	40	44
Dist. 6 Northeast	1	1						1		3	6			9	4	2	2	1	2			1	1	13	12	33			33	35	46	47
Dist. 7-B N. Central	9		2	2			2			15	57		1	73	65		11	12			4			92	57	287	1	1	289	187	381	244
Dist. 7-C W. Central				1			1			2	5			7	7		2	3			4			16	10	46		1	47	45	63	55
Dist. 8 West	3			1			3			7	23			30	21			5			20		1	47	36	99		3	102	86	149	122
Dist. 9 North	8		1	2			3			14	53		2	69	48		3	12			1			74	34	234		6	240	188	314	222
Dist. 10 Panhandle	1									1	1			2	2									2		3			3	2	5	2
Utah	1									1	1			2	1						1			2	1	6			6	11		1
Virginia																									1					8	12
Washington																													2		2
West Virginia																	4							4	2	1			1		5	2
Wyoming	1			4			1			6	10			16	6			9			5			20	21	57		3	60	29	80	50
Total U.S.	69	3	14	40	10	2	22	3	1	164	507		9	680	332	38	56	163	39	13	118	10	5	774	603	2794	2	32	2828	2436	3602	3039

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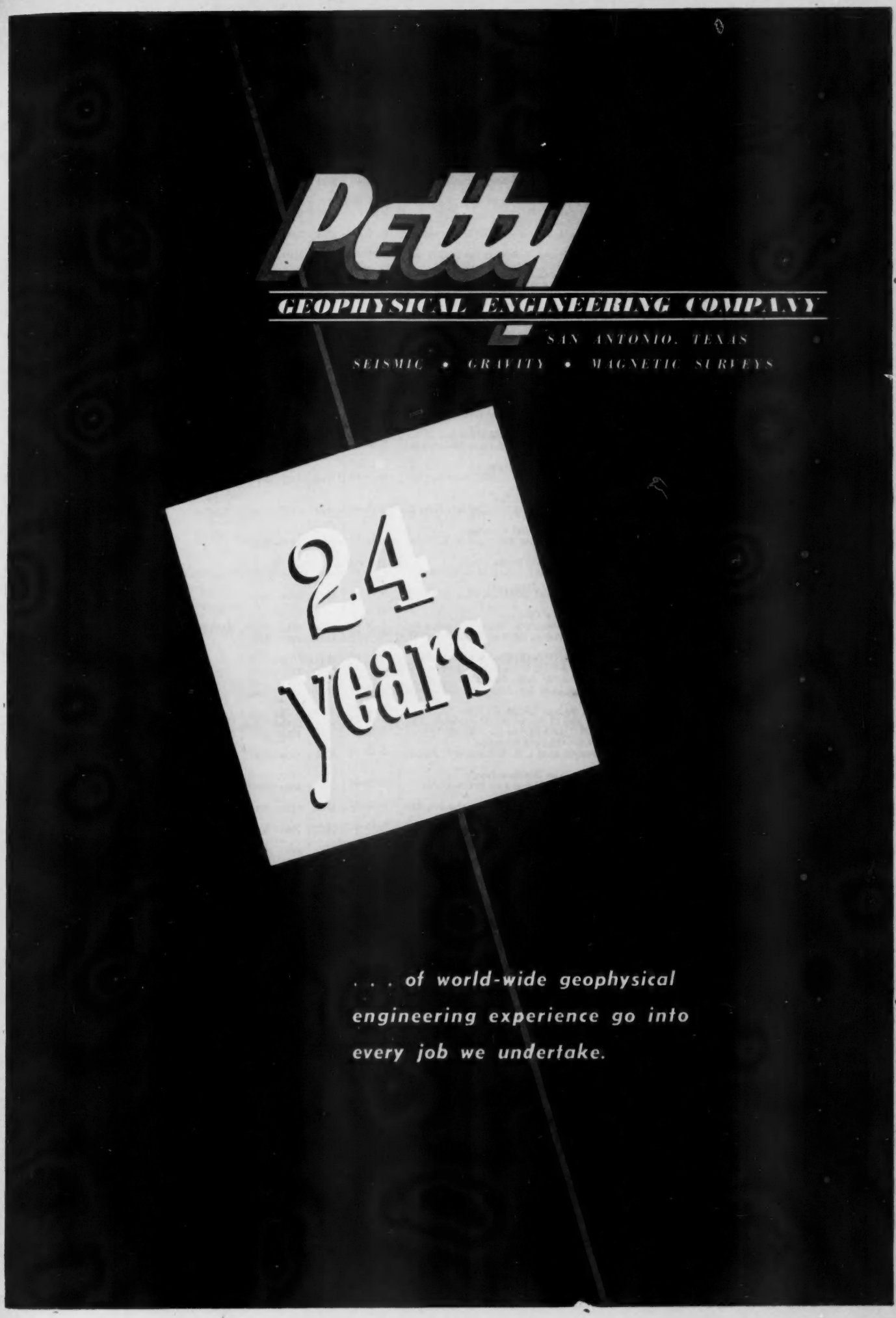
COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		ARKANSAS—New Oil Field						
Union		Marine Oil Co's Winn Estate 1, sw sw sw 11-18s-13w, 1½ mi e Urbana fld.	6- 4-49	3628	2547- 2553	Meakin sd; U. Cre	P 41; 4 wtr	26
		ARKANSAS—New Gas Field						
Crawford		Sher Developments, Inc's, Mrs. Ethel Hicks 1, c e½ w½ se 30-10n-31w	6-22-49	1874	1840- 1870		2 mln; open	
		CALIFORNIA—New Oil Pays						
Kern	Sheep Springs	Carneros Oil Co's Anderson Comm. 3, 660 s&w fr e¼ cor. 19-29s-21e	6-12-49	2530	2433- 2455	Phacoides sd; Mio	P 90	23
Kern	Tejon Hills	Carla Stafford Lewis & Associate's Carla 2, Sect. 29-12n-18w	6-20-49	2465	2428- 2463		P 55; 36 wtr	20.2
Ventura	Ojai	Humble O&R Co's Theo E. Hammond 1, 5100 n 1025 e fr swc 18-4n-2w	6- 9-49	4350	3980- 4032		P 50; 50 wtr	25
		CALIFORNIA—Oil Field Extension						
Kern	Mountain Vw.	Morton & Dolley's Derby 1, 330 s 1650 e fr w¼ cor 33-30s-29e, se extension	6-23-49	5421	5295- 5340		P 65; 7 wtr	25
		CALIFORNIA—New Gas Field						
Kern		Independent Exploration Co's Bolton 83, 1650 s 330 w fr nec 27-27s-19e.	6-25-49	4313	3202- 3239		3.3 mln; ⅜"	
		ILLINOIS—New Oil Fields						
Clark	Weaver	Schafer & Granholm's Cusick 1, nw ne sw 20-11n-10w, 4 mi w Prairie Creek (Ind.) fld.	6-14-49	2135	2086- 2095	Lime; Devo	P 6; 150 wtr	
Edgar	Dudley	C. M. Hickman's Brinkerhoff 1, nw nw ne 10-13n-13w	6-21-49	469	415- 468	Sand; Penn	P 30; 30 wtr	
Jasper	Ste. Marie, E.	Baldwin & Gragam's Burton 1, ne ne ne 33-6n-14w, 2 mi ne Ste. Marie fld.	6- 7-49	2800	2686- 2691	Rosiclare li; Miss	P 35	
		ILLINOIS—New Oil Pays						
Clay	Stanford	Johnson & Canfield's Nodaker 2, se nw sw 23-3n-7e, Stanford Twp.	5-10-49	2710	2681- 2710	Cypress sd; Miss	P 1; 70 wtr	
Gallatin	Inman, Cent.	Van Tuyl & Gilpin's Wilson 1, se ne se 36-7s-9e, 1 mi fr prod.	6-21-49	2956	2816- 2828	L. O'Hara li; Miss	P 108	
Gallatin	Omaha	George & Wrather's Patton 2, se sw sw 34-7s-8e, ½ mi fr prod.	6-21-49	402	375- 395	Sand; Penn	P 20	
Wayne	Fairfield	Nation Oil Co's Nation-Curry 3, se sw sw 17-2s-8e	6- 7-49	2564	2552- 2564	Tar Springs sd; Miss	P 670	
Wayne	Fairfield	Nation Oil Co's Nation-Curry 3-A, 330 fr sl 380 fr el sw sw 17-2s-8e	6-28-49	3316	3307- 3314	McClosky li; Miss	P 210; 15 wtr	
		ILLINOIS—Oil Field Extensions						
Clinton	Shattuc	Pruett et al's Twenhofel 1, nw nw sw 34-2n-1w, 1 mi s extension	6-21-49	1274	1260- 1272	Cypress sd; Miss	P 6	
Gallatin	Inman	Ashland O&R Co's D. S. Maloney 1, (OWWO), se se sw 25-8s-9e, 1 mi s extension.	6-14-49	2947	2126- 2150	Tar Springs sd; Miss	P 5; 25 wtr	
Wabash	Allendale	Hartman's Courter 1, 3859 fr nl 2396 fr wl 26-1n-12w, 1 mi extension	6-21-49	1445	1427- 1440	Biehl sd; Penn	P 5; 20 wtr	
Wabash	Maud Cons.	Oil Management Co. et al's Hare 1, ne nw se 1-1s-13w, 1¼ mi e extension	6-28-49	1672	1657- 1671	Biehl sd; Penn	P 35; 18 wtr	
		INDIANA—New Oil Fields						
Gibson	Wheatonville	Gilliam Drlg Co's Wm. R. Stitt 1, nw ne nw 12-4s-10w, 4 mi e Warrentown pl	6-23-49	2119	2014- 2018	O'Hara li; Miss		
					2050- 2056	McClosky li; Miss.	F 200	
Pike		J. C. West's Benham Farm 1, nw sw sw 4-2s-8w, Patoka Twp.	2-16-49	1263	1241- 1263	Jackson sd; Miss	P 15	
Spencer		George Dobbs' Williams 1, se se sw 22-6s-7w, 4 mi ne Hatfield pl.	6-24-49	968	958- 968	Waltersburg sd; Miss	P 27	
Vigo		H. P. Smith's Willard Blocksom 2, ne nw se 9-11n-9w, Honey Creek Twp.	5- 5-49	1706	1678- 1706	Devonian li; Devo	P 24	
		KANSAS—New Oil Fields						
Ellis		Westgate-Greenland Oil Co's A. Windholtz 1, sw sw sw 3-12s-17w, ½ mi s&e Bemis-Shutts fld.	6- 7-49	3596	3360- 3370	Lansing-K.C. li; Penn	P 57; 16 wtr	
Graham	Teall	M. B. Armer's Teall 1, nw nw se 9-10s-21w, 3 mi nw Morlan pl.	6-28-49	3822	3528- 3534	Lansing-K.C. li; Penn	P 32; 5 wtr	
Rice	Ringwald	Anderson-Prichard Oil Corp's Ringwald 1, ne se ne 32-18s-10w, 1½ mi s Orth, W. pool.	5-17-49	3090	2947- 2952	Lansing-K.C. li; Penn	F 375	40.3
Rooks	Eagle Creek	Francis O&G Co. et al's Wilson 1, ne ne ne 2-10s-20w, 2 mi se Northampton pool.	5-15-49	3834	3823- 3834	Arbuckle li; Ord	P 167	
Rooks		Harry Gore's Cramm 1, nw nw ne 28-7s-19w, 3 mi s Locust Grove fld.	6-28-49	3476	3331- 3339	Lansing-K.C. li; Penn	P 66	
Russell	Parker, NW.	Lindas Oil Co. & National Co-op Ref. Assoc's Parker 1, sw sw sw 7-15s-12w, ½ mi n&w Parker pl.	6-21-49	3308	3086- 3102	Lansing li; Penn	P 833; 167 wtr	
Stafford	Prairie Home	M. B. Armer's Andress 1, ne ne sw 2-21s-13w, 1 mi ne Rothgarn, E. pl.	5-20-49	3526	3512- 3526	Arbuckle li; Ord	P 242	
Stafford	Hildebrand, S.	M. B. Armer's Hildebrand 1, ne ne nw 11-24s-12w, ½ mi s Hildebrand Gas pl	6-21-49	3830	3809- 3830	Viola li; Ord	P 96	
Stafford	Mueller, W.	Midstates Oil Corp's McCrary 1-B, sw sw ne 24-21s-13w	6- 7-49	3673	3657- 3673	Arbuckle li; Ord	P 26	
Wabaunsee	Davis Ranch	Carter Oil Co.'s G. H. Davis 1, sw se sw 33-13s-10e, 10 mi s Alma	5-12-49	3206	3201- 3206	Viola li; Ord	P 435	29
		KANSAS—New Oil Pays						
Finney	Nunn	Shallow Water Refg. Co's Davis 3, (OWWO), sw se nw 26-21s-34w	5- 7-49	4703		Cherokee sd; Penn	F 230	
Pratt	Carmi	Champlin Refining Co's Steuder 3, sw sw sw 29-26s-12w	6-17-49	4000		Viola li; Ord		
Russell	Gustason	Plains Exploration Co's Kaufman 2, nw se se 14-15s-12w	6- 1-49	3325	2924- 2928	Dodge li; Penn	P 210	
		KANSAS—New Gas Field						
Cowley		Earl Wakefield & Bridgeport Oil Co's Robert's 1-A, se se se, 21-31s-5e	6-16-49	3556	2295- 2309	Layton sd; Penn	F 2.5 mln	
		KENTUCKY—New Oil Fields						
Daviess		J. C. Ellis-DGS' W. J. Foster 1, sw ne nw 2-P-28	6-24-49	964	958- 964	Palestine sd; Miss	P 5; 10 wtr	
Ohio		C. R. Craft & H. H. Vickers' Boyd Crowe 1, 3-L-31, 3 mi nw Hartford	6-14-49	1517	1441- 1497	McClosky li; Miss	P 53	
Union		J. Burhans-Sam Lewis-Basin Drlg-Pacific Opr. Co's Addie Y. Lilly 1, 22-O-19, 1 mi ne Morganfield, S. Pool.	6- 9-49	1900	1842- 1849	Waltersburg sd; Miss	P 147; 9 wtr	
		NORTH LOUISIANA—New Oil Pay						
Claiborne	Athens	Hurley Beene et al's Sam Hugh Neel 1, c ne nw 25-20n-7w	5-31-49	9156	6122- 6140	L. Travis Peak sd; L Cre	F 113; ¼"	45
		NORTH LOUISIANA—New Distillate Field						
Bossier	Sarepta	Barnsdall Oil Co., Sohio Pet. Co., & C. H. Murphy's Ardis 1, c ne nw 27-22n-11w.	6- 7-49	10019	8712- 8734 9156- 9186	Bodcaw sd; Jur Ardis sd; Jut	F 228; 3.8; 4/64" F 200; 1.1; ¼"	60.7 55.6
		SOUTH LOUISIANA—New Oil Field						
Jefferson	Avondale	Humble O&R Co's T&NORR 1, Sect. 26-13s-22e, 1½ mi w Westwego fld.	6-20-49	10229	8183- 8188		F 219; 4/64"	31
		SOUTH LOUISIANA—New Oil Pays						
Lafourche	Bay Marchand	California Oil Co's State Lse 1366-3-B, 6326 s 1656 e fr nec Blk 2, in Gulf	6-20-49	5034	3900- 3925		F 324; 4/64"	20.1
St. Martin	Duck Lake	Humble O&R Co's R. H. Goodrich et al 1-B, Sect. 2-15s-11e	6- 5-49	11747	11470-11475		F 421; 7/64"	33
Terrebonne	Bay Junop	Union Oil Co's State Lse 725-9-5, Sect. 27-21s-14e	6-24-49	4560	4500- 4504		F 84; 7/32"	40.7
Terrebonne	Caillou Island	The Texas Co's State Lse 301-Woods Unit 1-1, sw of USC&GS "LOU" in 40-ac unit, Sect. 25-23s-19e.	6-29-49	12417	9990-10008		F 238; 11/64"	46.2
		SOUTH LOUISIANA—New Distillate Field						
Acadia	Midland	Sun-Sohio Oil Co's Lapleau Est. 3, 1638 n 1900 w of sec Sect. 49-10s-2w	6-17-49	11850	10618-10630		F 134; 2.2; ⅛"	42.8
		SOUTH LOUISIANA—New Gas Field						
Vermilion		Pure Oil Co's St. Lse 880-1-B, 3690 n 570 w of sec N½ Blk 39, 8 mi in Gulf	6-10-49	10279	8195- 8220		F 12; 0.9 mln	51
		MICHIGAN—New Oil Fields						
Allegan		Ohio Oil Co's Jeran et al 1, se se se 25-2n-15w, Clyde Twp, 8 mi w Allegan	6-24-49	1282	1276- 1282	Traverse li; Devo	P 35; 20 wtr	
Barry		Fisher-McCall O&G, Inc's Steckle 1, se ne nw 6-4n-8w, Carlton Twp.	6-17-49	2042	2034- 2042	Traverse li; Devo	F 30	
Gladwin	Butman	H. E. Bell's Bronson & Fryling 1, ne nw nw 13-20n-1w, 11 mi n Buckeye, N.	6-17-49	3602	3595 -3602	Dundee li; Devo	P 62	35.6
Mecosta	"Paris-Green"	John A. Thompson's Cox 1, nw nw ne 28-16n-10w, Green Twp, 10 mi s Reed City fld.	6- 3-49	2890	2869- 2890	Traverse li; Devo	F 250	41
		MISSISSIPPI—New Oil Pay						
Franklin	Oldenburg	T. F. Hodge, Ralph Gilster & James E. Kemp's Lehmann Bros 1, c nw se nw 28-7n-2e.	6- 5-49	6055	5984- 5997	Wilcox sd; Eoc	F 245; 11/64	35.1
		NEBRASKA—New Oil Field						
Cheyenne	Gurley	Ohio Oil Co's Egging 1, ne ne ne 11-15n-49w, 12 mi ne Sidney	6-30-49	4429	4350- 4420	Muddy sd; U Cre	P 230	35
		OKLAHOMA—New Oil Fields						
Cotton	W.Rabbit Crk.	R. Denton Ross' Eastman 1, ne se ne 17-5s-12w	6- 4-49	1787	1754- 1756	Permian sd; Perm	P 27	41
Garvin	Paoli, SW.	Smiley, Little & M. T. Myers' Trudgeon 1, 660 fr nl 430 fr wl sw sw 14-4n-1w	6-23-49	4716	4429- 4441	Pennsylvania sd; Penn	F 77; 7/32"	43.4
Major		Mazda Oil Co. & Superior Oil Co's P. J. Boehs 1, ne sw se 30-22n-10w, 2 mi w Ringwood pl.	6- 2-49	6898	6796- 6800	Manning sd; Penn	F 82; ½"	40
Murray		Rinehart et al's Hassen 1, se sw ne 24-2n-3e	6-23-49	688	372- 377		P 4	25
Okfuskee	Rosenwald	Falcon-Seaboard Oil Co's Annie Sarnia 1, se se sw 14-13n-8e, 1¼ mi sw Welty, SW pool.	6- 9-49	3445	3430- 3445	Union Valley & Cromwell sd; Penn	F 888; ¼"	38
Payne	Prairie View	C. P. Quinlan's Lowe 1, ne nw sw 21-19n-1w	5-19-49	4962	4911- 4919	Skinner sd; Penn	F 25	42
Payne	Ramsey, NE.	Eddie Fisher's Flohr 1, se sw nw 5-18n-2e, 2 mi n Ramsey pool	6- 2-49	4414	4386- 4396	Skinner sd; Penn	P 50	37.6
Pontotoc		R. P. Traugh et al's Haney Est. 1, se se nw 22-4n-7e	6-23-49	2396	736- 762		F 8; 6 mln	31
Seminole		Ashland O&R Co's Fore 1, nw ne nw 26-7n-7e	6-12-49	1757	1747- 1757	Calvin sd; Penn	F 13; 4/64"	35
Seminole		W. A. Villines et al's Millsap 1, nw sw nw 30-7n-6e	6- 9-49	2504	2490- 2504	Calvin sd; Penn	P 5; 30 wtr	40.1
		OKLAHOMA—New Oil Pay						
Stephens	Doyle	Phillips Pet. Co's Feagin 1, c nw sw 18-1n-4w, ¾ mi se prod.	5-15-49	8712	8058- 8106	Springer sd; Penn	P 196	36
		OKLAHOMA—Oil Field Extensions						
Beckham	Elk City	Shell Oil Co's G. W. McKenzie 1, c ne sw 9-10n-21w, 1½ mi nw extension.	6- 9-49	10496	9400- 9435	Granite Wash; Penn	F 862; 1.3 mln	49.2
Lincoln	Davenport, SE	Creekmore-Rooney's Eason-Nickles 1, nw nw sw 19-14n-6e	6-23-49	3421	3343- 3421	Prue sd; Penn	P 35	34
Noble	Fourdee	Mazda Oil Co's Hoppe 1, se se nw 23-22n-2w	6- 2-49	5184	4823- 4842	Mississippi li; Miss	P 17; 5 wtr	42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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in June, 1949

CONTINUED

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
Okfuskee	Cary	Gulf Coast Western Co's McMahan 2-B, nw se sw 22-12n-10e, ¾ mi n extension.	6-16-49	3308	3290- 3308	Cromwell sd; Penn	P 15	30
Washita	Elk City	Max Pray et al's Proctor 1, (OWWO), c nw 28-10n-20w, e extension	6-16-49	14582	10760-11186	Granite Wash; Penn	F 4; 1.5 mln	48.5
		OKLAHOMA—New Gas Fields						
Coal		J. A. Roberson's J. W. Daniel 1, (OWDD), sw ne sw 27-1n-9e	6- 4-49	7218	6915- 6950		F 2 mln	
Oklahoma		Gulf Oil Corp's Maggie Perkins 1, c sw se 34-13n-2w	5-30-49	6245	5539- 5555	Cleveland sd; Penn	F 2 6 mln	
		TEXAS—District 1 (S. CENTRAL)—New Oil Fields						
Frio	Divot	M. L. Massingill et al's Rex Shuptrine 1, 1300 fr swl 1660 fr s'ly nwl N. Nanez Sur 1078, 2 mi e Doering fld.	6- 8-49	6705	5584- 6705	Austin Chalk li; U. Cre	F 188; $\frac{3}{16}$"	33
Williamson		Anderson-Prichard Oil Corp's Charlie Preusse 1, 4045 fr swl 1042 fr nwl R. E. Booth Sur, 6 mi se Taylor.	6-15-49	1138	1109- 1138		P 147	38.4
		TEXAS—District 1 (S. CENTRAL)—New Gas Pay						
Frio	Doering	Humble O&R Co's Frank Doering 2, 660 fr n&el BBB&C Sur, Blk 15, Leona Valley Fms Sbdn, 4500 fr oil prod.	6- 2-49	6507	4106- 4113	Navarro sd; U. Cre	F 6 mln; open	
		TEXAS—District 2 (MIDDLE GULF)—New Oil Field						
Live Oak	Goebel, N.	Henderson Coquat's W. W. Goebel & Sophia Goebel 1, 3600 fr wl 3100 fr nl Refugio CSL Sur 16, 1½ mi n Goebel fld.	6-15-49	7150	6641- 6654	Luling sd; Eoc	F 50; $\frac{5}{16}$"	43.1
		TEXAS—District 2 (MIDDLE GULF)—New Distillate Pays						
Goliad	Marshall	Sunray Oil Corp's J. B. Danforth 1, 660 fr swl 2800 fr sel of Tr, Solomon Griffin Sur, (New dist. & gas pays).	6-15-49	9502	4910- 4924 8924- 9002	Yegua sd; Eoc Massive Wilcox sd; Eoc	No gge; 2.3 mln	
Refugio	Roche	Hewit & Dougherty's K. D. Roche 42-A, Lot 19, Atkins & O'Neil Sbdn, D. J. Mitchell Sur.	6- 2-49	7065	6132- 6140		F 685; 60 mln	
Refugio	Rooke	Hewit & Dougherty's F. B. Rooke & Sons 2-D, 1100 fr el 850 fr sl Blk 27, J. M. Aldrete Gr.	6- 2-49	7417	6339- 6347		F 497; 22 mln	
Victoria	Mission Valley	Western Natural Gas Co's O. W. Schaefer 1, 4180 fr nel 3200 fr sel W. J. Eaton Sur, ¾ mi w prod.	5-30-49	8713	8585- 8614		F 82; 3.8 mln; ¼"	
		TEXAS—District 2 (MIDDLE GULF)—Distillate Field Extension						
Lavaca	Provident City	Shell Oil Co's E. A. Neuhaus 1, 9900 fr nel 1250 fr nwl Aaron Monroe Sur, 1 mi s extension.	6-23-49	8785	8570- 8723	Wilcox sd; Eoc	F 85; 4 mln; $\frac{5}{32}$"	49.5
		TEXAS—District 2 (MIDDLE GULF)—New Gas Field						
Lavaca		Sterling O&R Corp's R. H. Goodrich 1-B, (OWWO), 2517 fr nw&sel 660 fr nel German Imm. Co. Sur 43, 3 mi ne Hope fld.	6- 5-49	11014	2722- 2727		F 2.3 mln; ¼"	
		TEXAS—District 2 (MIDDLE GULF)—New Gas Pay						
Lavaca	Speaks	Grubb & Hawkins' E. P. Zock Trustee et al 1, 458 fr el 2583 fr sl Kelly & McElroy Sur, 1½ mi se prod.	6-16-49	2149	1780- 1792		No gge	
		TEXAS—District 2 (MIDDLE GULF)—Gas Field Extension						
Lavaca	Speaks	Grubb & Hawkins' Sylvia Krandel 1, 777 fr nwl 430 fr nel S. N. Oliver Sur, 1½ mi ne extension.	6-13-49	2102	1998- 2008		F 72 mln; open	
		TEXAS—District 3 (UPPER GULF)—New Oil Fields						
Hardin	Village Mills, E.	Houston Oil Co's Nona Fletcher Lbr. Co. et al 1, 1750 fr wl 9500 fr nl Geo. Brown Hrs. Lge, 2 mi se Village Mills fld.	6- 7-49	7495	7058- 7066	Yegua sd; Eoc	F 255; $\frac{5}{32}$"	41.2
Matagorda	Sargent	H. A. Potter's Henry T. Freeman 3, 675 fr nwl 1500 fr swl Thos. McCoy & D. Deckro Sur.	3-14-49	6610	6324- 6329		F 15; 48 wtr; $\frac{5}{32}$"	34.5
		TEXAS—District 3 (UPPER GULF)—New Oil Pays						
Brazoria	Manvel-Olig.	Jack W. Frazier's Campbell-Vredenburgh Unit 1, E. Littles Sur, on nw flk.	6- 9-49	5729	5612- 5619	Marginulina sd; Olig.	F 138; $\frac{11}{64}$"	26
Brazoria	W. Columbia (Deep)	Hogg Oil Co's Mike Hogg et al 10-A, 1830 fr nl 150 fr el 248.59-ac Lse, M. Varner Sur.	6- 1-49	7106	6026- 6048		P 247	33.7
Galveston	Hitchcock	Stewart Pet. Co's Fred Thomas et al 1, (OWWO), Cook & Stewart Sbdn	6- 6-49	6739	5088- 5096		F 102; ⅛"	32.1
Hardin	Batson	Progress Pet. Co's Myrtle Jordan 2, (OWWO), Willis Donaho Lge, on s flk.	6-17-49	5298	4788- 4796		P 75; 36 wtr	39.1
Hardin	Saratoga	D. D. Feldman's S. F. Bashara 4, 100-ac Tr, J. B. Reaves Sur	6- 5-49	7566	7200- 7235		F 138; $\frac{5}{64}$"	34.5
Harris	Pierce Jctn	McCarthy O&G Co's Jennie Settegast et al 1-A, 50-ac Lse, J. Kopman Sur, on sw flk.	6-19-49	7300	7234- 7240		F 172; $\frac{5}{16}$"	28.5
Liberty	S. Liberty	Gulf Oil Corp's Nonie O'Brien 3-A, 154.2-ac Lse, M. G. White Sur	6- 5-49	7503	6374- 6402	Yegua sd; Eoc	F 164; $\frac{5}{64}$"	38.3
Liberty	S. Liberty	L. M. Josey et al's Joseph Mitchell Est. 11, 160-ac Lse, M. G. White Sur	6- 2-49	6800	6366- 6438	Cook Mt. No. 1 sd; Eoc	F 216; $\frac{5}{64}$"	38
Liberty	Hankamer	R. Olsen Oil Co's Ezzell 1-A, (OWDD), Levi Barrow Sur, on n flk	6-28-49	4294	4258- 4294	Miocene	F 431; ¼"	26
		TEXAS—District 3 (UPPER GULF)—Oil Field Extension						
Jefferson	W. Beaumont	F. H. Carpenter et al's Kate Masterson et al 1, H. Williams & F. Bigner, Sur, east extension.	5-15-49	6061	5638- 5651	Oligocene	P 23	28
		TEXAS—District 3 (UPPER GULF)—New Distillate Pays						
Madison	Madisonville, W.	J. M. West's Ruby Magness 1, 5300 fr el 3700 fr sl Amy Boatright Sur	6-12-49	9660	8340- 8360	Sub-Clarksville sd; U. Cre	F 278; 14.8 mln; ½"	58.3
Matagorda	Arch	Rowan Oil Co. & Texas Gulf Prod Co's Denman Kountze et al 1-B, 330 fr s&wl ne ¼ Sect. 17, I&GN Sur, ¾ mi ne prod.	6-13-49	8721	7437- 7646	Frio sd; Olig	F 41; 1.4 mln; ¼"	
Polk	Copeland Crk.	R. H. Abercrombie's Texas Long Leaf Lbr. Co. 1, A. Viesca Lge	6-14-49	7512	7054- 7066	Wilcox sd; Eoc	F 87; 3.8 mln	57.7
		TEXAS—District 3 (UPPER GULF)—Distillate Field Extension						
Chambers	Mayes, E.	Humble O&R Co's M. E. Mayes 12, 800 fr wl 1267 fr sl Solomon Brill Sur, 1½ mi se extension.	6-10-49	9500	8794- 8800		F 120; 2 mln; ¼"	60.8
		TEXAS—District 3 (UPPER GULF)—New Gas Field						
Brazoria		Rowan Oil Co. & Texas Gulf Prod. Co's J. H. Blackwell 1, 467 fr nl I&GN Sur, 27, 467 fr el Lot 3, 4½ mi se Hastings fld.	5-27-49	10865	10554-10561	L. Frio sd; Olig.	F 0.5 mln; ⅛"	
		TEXAS—District 4 (LOWER GULF-S.W.)—New Oil Fields						
Duval	E. Realitos	Southern Mineral Corp's Leroy Denman 1, 467 fr sl 1350 fr wl Blk 84, Santos Garcia Gr, 1½ mi sw Longhorn, S. fld.	6-25-49	5605	4179- 4184 4253- 4256	U. Cole sd; Eoc Mid. Cole sd; Eoc	No gge (gas) F 62; $\frac{5}{64}$"	46.1
Duval	"N. San Diego"	Humble O&R Co's Enrique Garcia 1, 660 fr wl 1400 fr sl Tr. 2, Sh. 5, San Diego de Arriba Gr, 5 mi n-nw San Diego.	6-17-49	5004	4730- 4737		F 125; ⅛"	48.6
		TEXAS—District 4 (LOWER GULF-S.W.)—New Oil Pays						
Nueces	Calallen	Bridwell Oil Co's L. I. Reagan 1, Lot 6, Reagan Sbdn of McIntyre Part, M. Lopez de Herrera Gr.	6-22-49	7800	7246- 7249		F 104; $\frac{5}{64}$"	37.5
San Patricio	E. White Pt.	Shell Oil Co's J. R. Kirk 6, 775 fr sl 390 fr wl Sect 50, Geo. H. Paul Sbdn	6- 1-49	6818	6766- 6767		F 189; $\frac{5}{64}$"	43.1
		TEXAS—District 4 (LOWER GULF-S.W.)—Oil Field Extension						
Duval	Agua Prieta	Taylor Refg. Co's Parr 2-R, (OWDD), J. Poitevent Sur 279, ½ mi ne extn.	5- 8-49	4611	4303- 4310	Yegua sd; Eoc	F 71; $\frac{5}{64}$"	48.3
		TEXAS—District 4 (LOWER GULF-S.W.)—New Distillate Pays						
San Patricio	Sinton	Plymouth Oil Co's R. H. Welder 4-B, (OWDD), Sect 80, Eliza H. Welder Rch Sbdn.	5-28-49	7510	7845- 7850		F 120; 30 mln	
Starr	Yzaguirre	British-American Oil Prod. Co's T. B. Slick Est. 2, Yzaguirre Sur 230	5-15-49	8974	4890- 4902		F 56; 6.2 mln	
Starr	Yzaguirre	Coastal Refineries Inc's Manuel F. Yzaguirre 1, (OWWO), 640-ac Tr, Yzaguirre Sur 227.	3- 1-49	5258	4854- 4864		F 150; 3 mln; ¼"	
		TEXAS—District 4 (LOWER GULF-W.S.)—New Gas Fields						
Duval	Zaragoza	Edwin B. Cox, Jake L. Hamon & Geo. H. Coates' A. Lopez 1, 330 fr n&el AB&M Sur 731, 1 mi se Lopez fld.	6-17-49	2918	2289- 2293	Mirando sd; Eoc	F 1.2 mln; open	
Jim Hogg		Coast Co., Lucky & Neuhaus' Mrs. S. K. East 1, 120 fr el 330 fr sl Blk 330, Pippin Sbdn, El Randado Antonio Garcia Gr, 2 mi se Chaparosa fld.	6- 2-49	3778	3742- 3746		F 4 mln; open	
San Patricio		Quintana Pet. Corp's J. H. Harvey 1, 330 fr w&nl Lot 8, Rincon Sbdn, Geo. Sargent Sur, 3½ mi n Gregory.	5-15-49	13950	9978- 9984		No gge	
		TEXAS—District 4 (LOWER GULF-S.W.)—New Gas Pay						
Duval	Hoffman	Bridwell Oil Co. & J. W. Gorman's Juan Flores et al 1, G. Mirales Sur 118.	6-21-49	2705	1938- 1948		F 1.5 mln	
		TEXAS—District 5 (E. CENTRAL)—New Oil Field						
Hill		H. L. & L. F. Boaz' J. T. Jones Est. 1, 150 fr sl 755 fr el BBB&C RR Sur,	6- 2-49	733	720- 733	Woodbine sd; U. Cre	P 5; 1 wtr	29.6
		TEXAS—District 6 (NORTHEAST)—New Oil Field						
Wood	Nolan Edward	Bobby Manziel's Maud Thompson 1, 3500 fr nl 5280 fr wl Swanson Yarbrough Sur, 2½ mi nw Mineola.	6-25-49	5635	4691- 4724	Sub-Clarksville sd; U. Cre	P 108	20
		TEXAS—District 6 (NORTHEAST)—New Distillate Field						
Nacogdoches		Humble O&R Co's Thurman Crawford et al 1, 660 fr el Zimri Bennett Sur, 660 fr nl Lse, 2 mi nw Trawick.	6- 3-49	8257	7498- 7540	Pettit li; L. Cre.	F 235; 47 mln	49.1
		TEXAS—District 6 (NORTHEAST)—Distillate Field Extension						
Shelby	Joaquin	Paul H. Pewitt's Ann Irish 1, 467 fr nwl 3400 fr swl Thos. Kilgore Sur, 1½ mi e extension.	6-16-49	6153	4870- 4882	Hill sd; L. Cre	F 126; 18 mln; open	

The City National Bank

OF HOUSTON

CONDENSED STATEMENT OF CONDITION AS OF THE CLOSE OF BUSINESS JUNE 30, 1949

RESOURCES

Cash and Due from Banks	$58,758,669.01	
U. S. Government Bonds	55,082,458.73	
Municipal Bonds and Warrants	1,188,220.44	
Federal Reserve Bank Stock	300,000.00	
Other Investments	800,000.00	$116,129,348.18
Loans and Discounts	42,620,964.85	
Commodity Loans Secured by Warehouse Receipts	1,267,852.97	43,888,817.82
Bank Premises	4,000,000.00	
Furniture and Fixtures	1.00	4,000,001.00
Interest on Securities and Other Income Earned—Not Collected		251,985.39
Customers' Liability on Letters of Credit		4,451,482.26
TOTAL RESOURCES		$168,721,634.65

LIABILITIES

Common Stock	$ 5,000,000.00	
Surplus	5,000,000.00	
Undivided Profits	1,494,801.30	
TOTAL CAPITAL ACCOUNT		$ 11,494,801.30
Reserve Accounts		537,162.27
Liability on Letters of Credit		4,451,482.26
DEPOSITS:		
Individual	$120,205,173.24	
Banks	31,253,411.18	
Government	779,604.40	152,238,188.82
TOTAL LIABILITIES		$168,721,634.65

CAPITAL & SURPLUS $10,000,000.00

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J. W. KEELAND
Executive Vice President

J. A. ELKINS, JR.
First Vice President

JOHN M. GRIFFITH
Vice President

H. L. SADLER
Vice President

GUY H. HEATH
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Vice President

W. J. KEITT
Vice President

W. C. MENASCO
Vice President and Cashier

DAVID MAHOOD
Vice President

FRANK C. GUTHRIE
Vice President

FRED P. HAMILL
Vice President and Trust Officer

DAVID T. HEDGES
Vice President

EBEN D. JUNKIN
Assistant Vice President

A. G. GUEYMARD
Assistant Vice President

C. C. SPENCER
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LEONARD McGOWAN
Assistant Cashier

JACK PATTERSON
Assistant Cashier

LEON BONDURANT
Assistant Cashier

W. GREER HUBBARD
Assistant Cashier

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MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in June, 1949

CONTINUED

Also Important Extensions to Established Fields

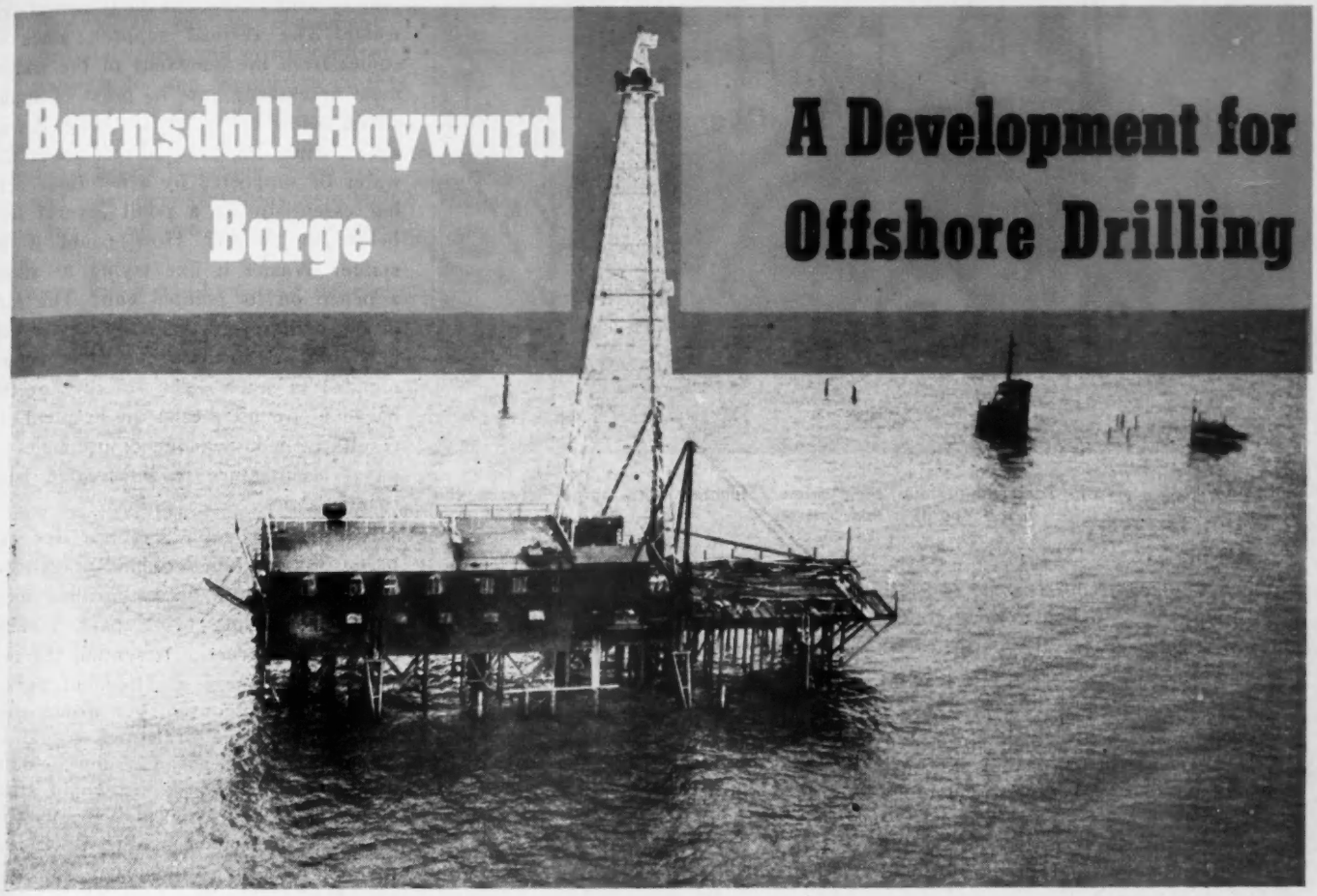
COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—District 7-B (N. CENTRAL)—New Oil Fields						
Callahan		Culvahouse & Powell's Lucy Debrell 1, 600 fr nl 450 fr el Blk 45, Comal CSL Sur, 5 mi sw Cross Plains.	5- 6-49	450	445- 450		P 4	39
Coleman		Dale Smith & M. R. Rogers' Mary A. Kirkpatrick 1, 447 fr nl 322 fr wl 84.5-ac Lse, Sect. 61, HT&B Sur, 1 mi se Santa Anna.	6-19-49	1795	1710- 1735		P 46	43.4
Eastland		Jack T. Lake Trustee's A. A. Tyler Fee 1, 330 fr n&el nw Sect 21, Blk 2, ETRR Sur, 9 mi w Rising Star.	6-20-49	2505	2475- 2505	Caddo li; Penn	P 5	37
Jones		Danciger O&R Co's C. L. Hailey 1, 330 fr n&wl ne sw Sect 29, Blk 15, T&P Sur, 4 mi ne Hawley.	6-23-49	2363	2340- 2363	Swastika sd; Penn	P 21	39
Shackelford		Hedrick Oil Co. Ltd's Chloe A. Nail 1, 2721 fr el 2737 fr sl Sect. 120, ETRR Sur, 8 mi nw Albany.	6-12-49	1367	1358- 1367		F 30; 3/4"	37
Stephens		Hill & Hill's Wm. Black 1, 330 fr ne&sel ne Sect. 1144, TE&L Sur	6- 6-49	3275	3242- 3275	Caddo li; Penn	P 21	40
Taylor		West Central Drlg Co's W. U. Beene 1, 990 fr wl 1120 fr sl Lot 4, D. B. Corley Sur, 4 mi n Tye.	6-14-49	3239	2340- 2348	Flippen sd; Penn	P 76	38
Throck-morton		R. W. Fair & Don L. Choate's M. C. Lee 1, 1107 fr nl 1263 fr el Sect 2358, TE&L Sur, 5 mi ne Woodson.	6-13-49	3886	3856- 3886	Caddo li; Penn	F 32; 7/32"	42
Thock-morton		Jas. H. Snowden's G. D. Dickie Unit 1-1, 1241 fr nl 880 fr el Sect. 686, TE&L Sur, 1½ mi sw Woodson	6-26-49	4531	4513- 4521	Mississippi li; Miss	F 754; 3/8"	41.2
		TEXAS—District 7-B (N. CENTRAL)—New Oil Pays						
Stephens	Unnamed	McElroy Ranch Co's J. Barker et al 2, 831 fr el 772 fr sl Sect. 3, Blk 8, T&P Sur, ½ mi se prod.	6-10-49	4450	3256- 3262	Caddo li; Penn	F 187; 11/64"	40.4
Taylor	Bird	Geochemical Surveys, Inc's Craig Humphreys 1, 1015 fr el 910 fr sl Blk 28, Lge 147, Grimes CSL.	6- 4-49	2783	2572- 2576	Cook sd; Penn	F 467; 7/32"	
		TEXAS—District 7-B (N. CENTRAL)—Oil Field Extensions						
Jones		J. C. Drilling Co's H. C. Harvey 1, 330 fr e'ly nl 2291 fr e'ly el Sect. 11, Blk 14, T&P Sur, ½ mi s extension.	6-28-49	1719	1698- 1715	Bluff Creek sd; Penn	P 600	39
Stephens	Double D	Osford Drlg Co's McMahon & Doss 1-A, 345 fr el 569 fr sl Sect. 1533, TE&L Sur, 1¼ mi n extension.	6-10-49	4386	4376- 4386	Ellenburger li; Ord	F 300; 1/8"	43
		TEXAS—District 7-B (N. CENTRAL)—New Gas Fields						
Shackelford		Twin Oil Co. & G. E. Kadane & Sons et al's Laura R. Dosser Hrs. 1-B, 330 fr n&el of sw Sect. 13, Bayland OAL, 3½ mi sw Ibex.	6-17-49	4272	3906- 3914	Conglomerate	F 7 mln	
Stephens		Algord Oil Co's K. P. Hughes 2, 1980 fr s&el Sect. 1, MEP&P Sur	6-22-49	4137	3922- 3968	Caddo cgl; Penn	F 0.9 mln	
		TEXAS—District 7-C (W. CENTRAL)—New Oil Pay						
Tom Green	Susan Peak	Plymouth Oil Co's John D. Robertson 3-A, 680 fr nl 1980 fr el Sect. 193, Dist. 11, SPRR Sur.	6- 7-49	4756	4360- 4400	Canyon sd; Penn	P 68; 5 wtr	42.4
		TEXAS—District 7-C (W. CENTRAL)—Oil Field Extension						
Upton	Benedum-Fusselman	Slick-Urschel Oil Co's H. F. Neal 1, se ne Sect. 14, Blk 4½, GC&SF Sur, 1¼ mi s extension.	6-19-49	11564	11080-11423	Fusselman li; Sil	F 594; 3/8"	61.5
		TEXAS—District 8 (WEST)—New Oil Fields						
Borden		Sinclair O&G Co's Sterling Williams 1, ne ne Sect. 45, Blk 32, T-6-N, ELRR Sur, 11 mi nw Gail.	6-18-49	10035	9903- 9933	Ellenburger li; Ord	F 664; open	42.8
Ector		Forest Oil Corp's Phillips-TXL 1, ne nw Sect. 25, Blk 45, T-1-S, T&P Sur, 1½ mi w Goldsmith fld.	6-24-49	6300	5740- 5875	Clear Fork li; Perm	P 200; 25 wtr	35.4
Howard		Magnolia Pet. Co's Herman Gartner 1-A, nw nw Sect. 67, Blk 20, Lavaca Navigation Co. Sur, ne Vincent fld.	6-13-49	8542	8199- 8215	Mississippi li; Miss	P 60; 6 wtr	41
		TEXAS—District 8 (WEST)—New Oil Pay						
Andrews	Dollarhide	Cities Service Oil Co's R. W. Cowden 1-E, sw sw Sect. 14, Blk A-52, PSL	6-15-49	8792	6545- 6650	Clear Fork sd; Perm	F 492; 4/16"	38.9
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Loving	Tunstill	C. O. Davis, McDaniel & Beecherl's TXL 1-B, 330 fr s&el Sect. 37, Blk 56, T-1, T&P Sur, ne extension.	6-15-49	3600	3522- 3564	Delaware sd; Perm	P 45	42
Scurry	Snyder, N	Sunray Oil Corp's R. B. Brown 1, 660 fr n&wl Tr. 8, Sect. 20, J. P. Smith Sur, 3 mi s extension.	4-25-49	6644	6532- 6644	Canyon li; Penn	F 1057; ½"	44.2
Sterling	Water Valley	Placid Oil Co. & Ohio Oil Co's L. T. Clark 3, ne ne Sect. 81, Blk 5, H&TC Sur, 2 mi sw extension.	6-13-49	1323	890- 1147	San Andres sd; Perm	P 17; 17 wtr	36
		TEXAS—District 9 (NORTH)—New Oil Fields						
Archer		Bay Pet. Corp's Wm. McGregor Est. 1, 330 fr n&wl 80-ac Lse, Sect. 7, H. H. Duff Sur, 3 mi sw Vogtsberger fld.	6-29-49	5758	5479- 5484	Bend cgl; Penn	F 46; ¼"	42.8
Archer		Revier Drlg Co's J. H. Roberson 1, 750 fr s&el Blk 15, J. W. Harris Sbdn	5-31-49	1415	1413- 1415		P 27	
Archer		Southern Pet. Explo. & Chas. E. Morrison's L. F. Wilson 2-F, (OWWO), 1790 fr sl 1850 fr wl Blk 120, ATNCL Sur, 2½ mi sw Chalk Hill fld.	5-21-49	4351	1162- 1168		P 96	
Archer		Stewart Pet. Co's Mrs. J. H. Turbeville 1, 863 fr nl 1400 fr wl Blk 148, R. Carson Sur, 3 mi se Hunter fld.	6-29-49	3833	3828- 3833		F 19; 4/16"	43
Cooke		J. R. & Adam Seitz et al's Nancy Mitchell 1, 330 fr e'ly wl 1000 fr e'ly sl, G. DeLos Santos Sur, 1 mi s Woodbine fld.	6- 5-49	4028	4021- 4028		P 46	27
Denton		Harrigan Bros et al's J. R. Knox Est. 1, 990 fr n&wl D. Boone Sur, 2 mi nw Bolivar.	6- 4-49	1538	1531- 1538		P 74	35
Jack		Jas. Blaine Divine's Elda Eatherly 1, (OWWO), 330 fr el 1263 fr sl J. T. Dawson Sur, 2½ mi nw Bryson.	6-18-49	4542	4480- 4497	Conglomerate	F 126; 4/16"	
Jack		Russell Maguire's R. E. Kelsey 1, 467 fr s&el B. B. Straughn Sur, 1 mi s Worsham-Steed fld.	6-28-49	4580	4566- 4574	Caddo cgl; Penn	F 235; ¼"	43
		TEXAS—District 9 (NORTH)—New Oil Pays						
Archer	Medders-Hancock	Wm. & J. J. Moran's Wm. McGregor 2, 1261 fr sl 2970 fr wl Sect. 4, Blk 1, H&TC Sur.	6-21-49	5721	4665- 4673	Vogtsberger sd; Penn	F 483; 4/16"	43
Wise	Unnamed	Signal O&G Co., T. W. & J. M. Loffland Jr's Dr. Jack Daly Unit 2-1, 660 fr n&wl Sect. 48, J. F. Williamson Sur.	6-22-49	3882	3874- 3882	Caddo li; Penn	F 116; ¼"	37.4
		TEXAS—District 9 (NORTH)—Oil Field Extension						
Jack	Ellis	Hanlon-Boyle, Inc's Bertha Moore 1, 1934 fr w'ly el 1923 fr w'ly sl J. W. Williams Sur, 1 mi s extension.	6-15-49	4590	4561- 4588	Caddo li; Penn	F 336; ¼"	41
Jack	Post Oak	Mid-Continent Pet. Corp's C. E. Campsey 1, 330 fr n&wl M. W. Thompson Sur, 1 mi se extension.	6-22-49	6415	6333- 6357	Ellenburger li; Ord	F 616; ¼"	45.2
Montague	Bowers, S	S. D. Johnson's Pauline Hamilton 1, 330 fr n&wl D. Redwine Sur, 2 mi s extension.	5-30-49	2883	2865- 2875	Strawn sd; Penn	P 77	41.6
		TEXAS—District 9 (NORTH)—New Gas Field						
Jack		R. B. Thrift's Hart-Lewis 1, 2850 fr sl 5700 fr wl Harvey Martin Sur	6- 3-49	5619	5015- 5043	Caddo cgl; Penn	F 4.8 mln	
		TEXAS—District 10 (PANHANDLE)—New Oil Field						
Roberts		Sinclair O&G Co's Charles Lips 1, ne nw Sect, 135, Blk C, G&M Sur	5-13-49	9556	8900- 8970	Mississippi li; Miss	F 420	45
		UTAH—New Oil Field						
Uintah		Carter Oil Co. & Stanolind O&G Co's Ute-Tribal 1, c nw sw 21-1s-1e, Roosevelt area.	6-30-49	9392	9357- 9391	Basal Tertiary	F 1633; open	32.6
		WYOMING—New Oil Field						
Hot Springs		Barnsdall Oil Co. & Sohio Oil Co's Unit 1, c sw ne 14-43n-92w, 3 mi nw Lake Creek fld.	6-17-49	3796	3751- 3796	Tensleep sd; Penn	F 144; 1"	31
		WYOMING—New Oil Pays						
Johnson	Sussex	Continental Oil Co's Unit 4, nw sw nw 17-42n-78w, ½ mi nw prod.	6-17-49	7867	4530- 4568	Shannon sd; U. Cre	Sw 240	40
Niobrara	Cow Gulch	South Texas Dev. Co's Gov't 2, se ne ne 8-36n-62w	6-30-49	1422	1419- 1422	1st Leo sd; Penn	P 80	30
Niobrara	L. Buck Creek	Continental Oil Co's Bowman 10 (ELCU B-14), ne ne se 26-36n-64w	6-23-49	6531	5754- 5782	1st Leo sd; Penn	F 192; 4/16"	32
Weston		Schlaikjer Bros, Lanam & Weir's Sterling 1, c ne sw 33-46n-66w, on Hay Crk.	6-30-49	6446	6190- 6220	Newcastle sd; U. Cre	P 60	39.6
		WYOMING—Oil Field Extension						
Weston	Fiddler Creek	Trigood Oil Co's Jessie 1-A, se se ne 12-46n-65w, 2¼ mi nw extension	6-17-49	4363	4320- 4363	Newcastle sd; U. Cre	P 68	

[1] Character producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd; sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

Barnsdall-Hayward Barge

A Development for Offshore Drilling



Breton Rig 20 on location. Submerged hull in background is LSM sunk previously to give bottom information and to act as a breakwater to the southeast.

By DR. PAUL WOLFF

THE SUBMERGIBLE hull forming the foundation for an offshore rig is examined and the factors determining its stability, wave transparency, and maneuvering are clarified by the author in this description of the design, construction, and first cycle of operation of this method of solving the support problem of deep-water drilling.

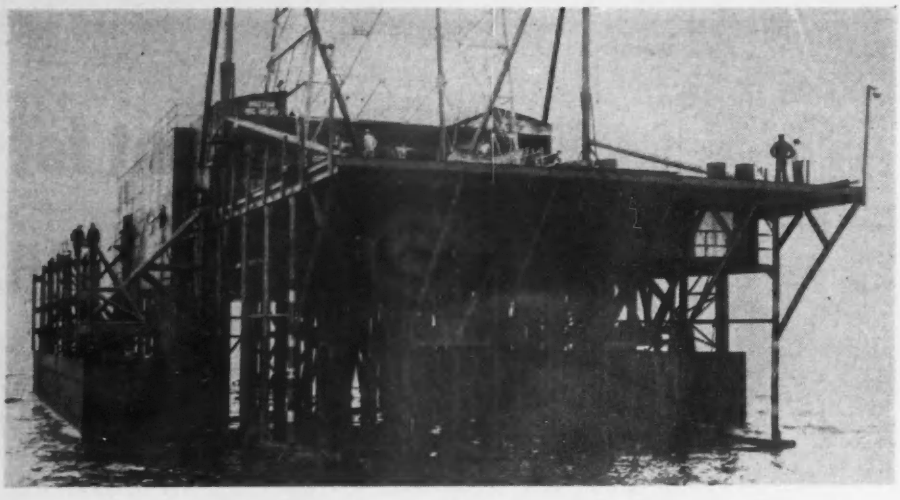
LESS than two years ago John Hayward said: "If I were ten years younger, I would go down to the Gulf and figure out a better and cheaper method for drilling in deep water."

Just a few weeks ago Barnsdall and partners' Breton Rig 20, a revolutionary submersible deep-water drilling barge, developed and built under Hayward's supervision, was moved off its first hole to begin its second. All that transpired between the two incidents demonstrates the application of a deliberate, critical, scientific approach supplemented by determination to see it through.

Routine sound engineering practice of companies operating in the Gulf has brought into use three general solutions to the deep water drilling problem: (1) an extended use of the conventional submersible shallow water drilling barge; (2) the use of pile foundations for drilling platforms; and (3) a combination of pile foundation and nearby floating tenders. The conventional type of submersible drilling barge is satisfactory for use only in shallow protected waters. When its ballast compartments are light it can be floated into position, its seacocks are then opened, and it sinks until it is supported by the ground, its machinery deck well above the water. Dumping large quantities of shell can prepare a deep water Gulf location to sustain a shallow water drilling barge in the same partly submerged position. When so arranged, the barge is resting on a partly submerged island, and there is a large totally enclosed volume between the water surface and its main deck. In this position the barge acts like a ship aground.

The reader may recall that about 15 years ago the "Morro Castle," a large passenger liner, afire and aground during a northeast storm, was moved about one-half mile through constantly shoaling water to rest still upright on the bathing beach of Asbury Park, N. J., by the action of wind and waves on its totally enclosed volume at the region encountered by the water surface.

The same kind of thing has happened to shallow water drilling barges. The difficulty is that the buoyant force, equal to the weight of the displaced liquid, acts on a body whether it is totally or partially submerged, whether or not it is hollow, and whether or not it sits on bottom. Suppose, for example, a conventional drilling barge that is resting partly submerged on a shell island comes under the influence of a sea where the combination of waves and swell causes a variation of ten feet in depth of water surrounding the barge. Since water cannot flow in and out of open sea-cocks fast enough to keep up with waves and swells, there will be a corresponding variation in bottom loading of 640 pounds per square foot, or 2400 tons on a 50- by 100-foot barge. This change is probably more than twice the weight of the dry barge. This minimum bottom loading will occur at a time when a maximum amount of water



Barge with deck awash. Pontoons perform their primary function with barge between this position and bottom.

moving with maximum velocity is passing around the hull. Under these conditions it is possible for the barge to be moved inch by inch off the island. During one of these early inches the well will be lost.

One alternative to a drilling barge is the pile foundation. It is a tremendous undertaking, not only in the construction itself but also in the moving of drilling equipment, and in the removal of the foundation in the event of a dry hole. The estimated costs all told of such foundations have been between $\$3/4$ million and $2 million in the normally poor bottom conditions of the Gulf where a large 100-foot H-section dropped on end may sink by its weight alone until it has gone 40 feet into the bottom.

This was the state of the art when Barnsdall and partners seriously considered offshore operations in the Gulf. Since commercially available methods were so tremendously expensive, it appeared that there was a need for something new. The first steps of the development consisted of the recognition of the need in terms of definite specifications and the planning of a device that would fulfill them. The requirements were cheapness, portability, transparency to wave action, and negligible change in buoyancy with change in surrounding water level. Hayward's recommendation was to build a completely new drilling barge. The drilling platform, machinery space, and quarters were to be a rigid unit separated from a supporting rectangular hull by widely spaced columns of small cross-sectional area (i.e., small totally enclosed volume). With the submersible hull resting on bottom and covered by six or seven feet of water, the rig would be immune to wave action, since practically all the wave energy would lie above the hull deck in the space which is substantially transparent to waves. Recognition of the fact that, except at thermal discontinuities, wave action decreases very rapidly with distance below the surface led to the invention of the submarine, first as a means toward a smooth sea trip for transoceanic passengers rather than as an instrument of war.

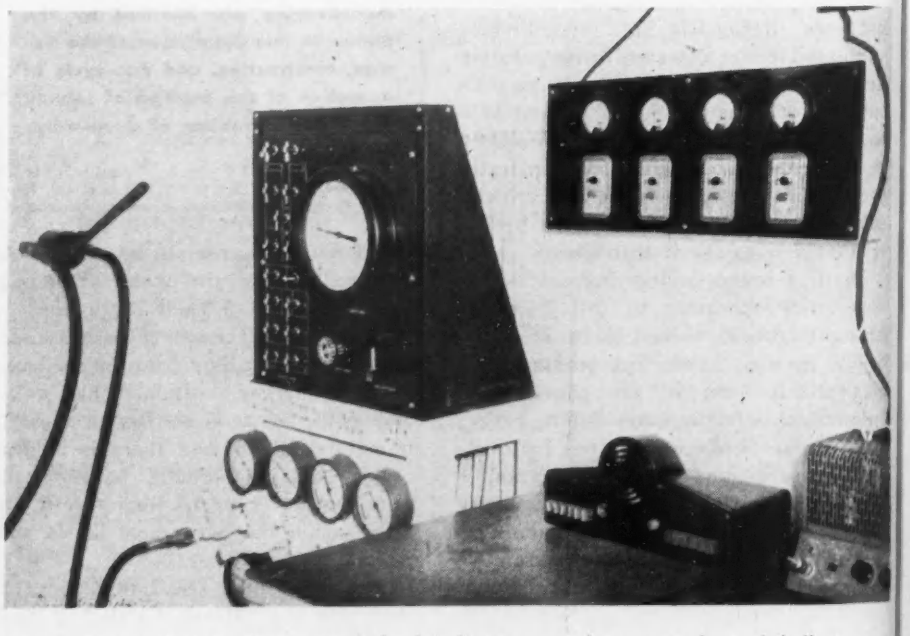
Hull Is Re-usable

In a complete rig of any sort the quarters, drilling equipment, and machinery must be provided anyway. The submerged hull, being permanently attached to the equipment above, would necessarily be re-usable from location to location, and further would effect a great saving in moving expense.

At an early date it became apparent that when the whole proposed rig should be towed to its location its center of gravity would be about thirty feet above water. The vertical support, since it comes from the buoyancy of the water, must necessarily have its point of application below the waterline. How, it was asked, could anything 30 feet above the water be supported by a net force acting essentially at a point several feet below the water? How could it be stable? Wasn't it like trying to stand a pencil on its pointed end? The fact of the matter is that such a device can be stable, and in the proportions recommended is stable. The stability of the barge is by no means an accident. It results from knowledge of principles of naval architecture to be treated later in this article.

Selecting the manufacturer for the barge was a problem of first magnitude. Since lease rental on the drilling location was already being paid, making speed of construction essential, the two ordinarily separate development phases of detailing and construction would overlap into one; the draftsmen would be about two weeks ahead of the welders; hundreds of complications would arise; and many practical matters would have to be decided upon as the work progressed and the problems were really visualized for the first time. There would be workmen from two major organizations and other smaller ones to be coordinated. A small and flexible shipyard, free of red tape, and with engineering and managerial competence of the highest order was necessary.

A launching of any kind is an awesome thing. The small shipyard handles a relatively large job like this rig by building on land only that part of the



Corner of control room showing tank level indicator, ram force controls, and ballast pump motor controls.

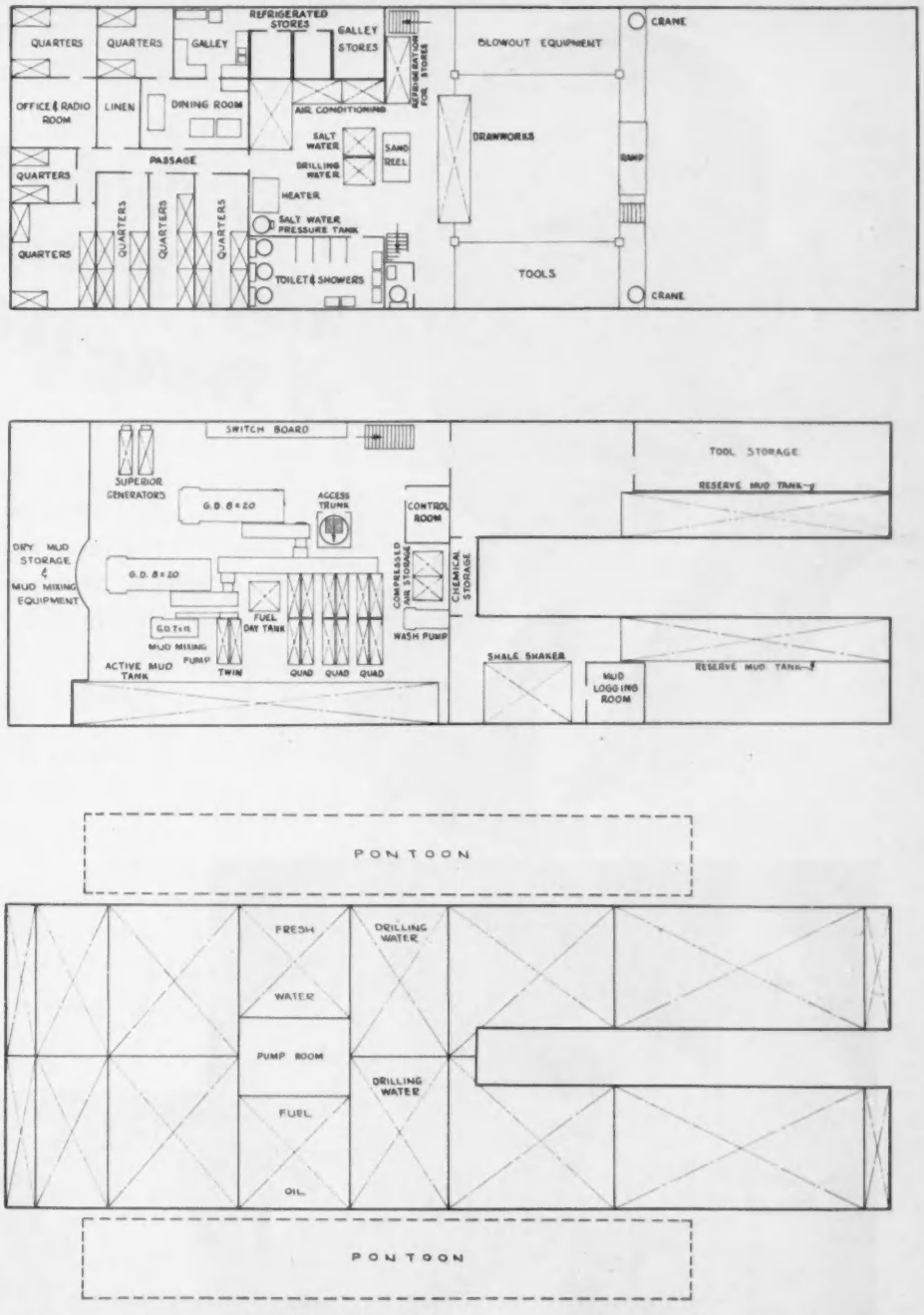
structure which can be conveniently launched and which will provide a floating platform for the completion of the rest of the work. In this case only the submersible part, the hull proper, was assembled before launching. Superstructure and machinery platforms were built up with the hull tied alongside an open dock.

Except for a five-foot rake on each end and the conventional drilling barge slot, the hull proper is a rectangular box 160 x 54 x 13 feet. Water-tight bulkheads divide the hull into 13 major and four rake compartments. These provide space for sea water ballast, a pump room, about 1000 barrels of fuel oil, 1000 barrels of drinking water, and 23,000 barrels of drilling water. The filling line heads to the liquid storage are specially designed to prevent over-pressurizing the hull by a supply pump through a direct connection. Each compartment is vented to a point above the waterline. There is access to each compartment through manholes on the deck while the barge is afloat, and to the pump room at all times by a five-foot diameter watertight trunk from the deck above. The forward end of the hull provides an estimated effective area of more than 700 square feet for engine cooling.

Ballast and Transfer Pumps

Since the machinery deck is 32 feet above the hull bottom, it is necessary to install the ballast and transfer pumps in the hull. Four bronze 1500 gallons per minute, 30 horsepower vertical shaft centrifugal pumps act as ballast and salt water standby pumps. Two 35 gpm, 50 pounds per square inch centrifugals discharge fresh water into a galvanized pressure tank through a supercharger which automatically keeps a proper volume of air in the pressure tank. The pump room bilge is handled by a 50 gpm bronze rotary. The above pumps were procured as surplus items from LST's. Two centrifugal pumps are used as fresh and salt water transfer pumps, the former 1½ inch, three hp; the latter two inch, six hp. The impellers were cut to match the flow, head, and horsepower of each pump. Two 4 gpm one-fourth hp rotary pumps serve to transfer fuel oil from the hull compartment tank to the day-tank above. All pumps are direct drive from 230-volt dc motors. The fields of these motors are continuously excited so that the heat loss will prevent their sweating when standing by.

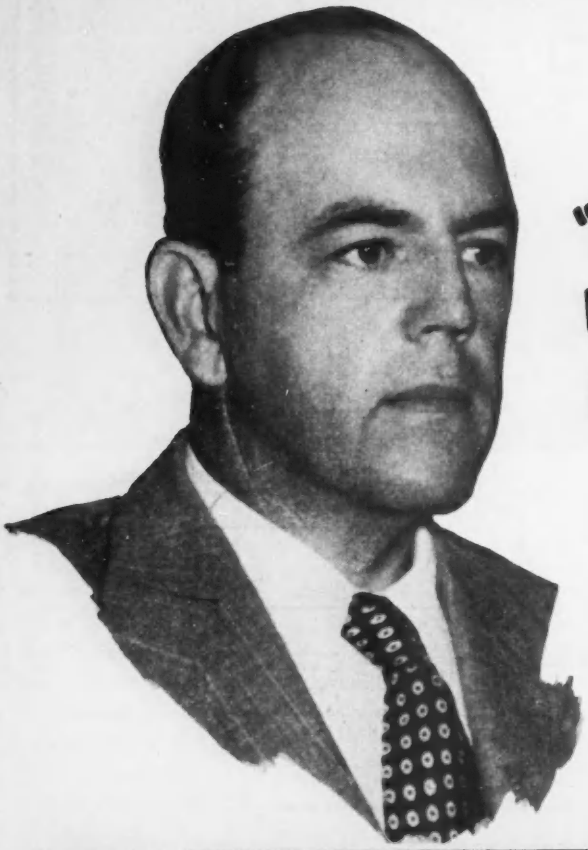
The machinery deck contains the engine room, the control room, the dry mud room with handling equipment, tool storage space, chemical room, mud logging room, 600-barrel active mud tank, and two 400-barrel reserve mud tanks. The active mud tank is separated from the engine room by a windowless bulkhead. As further protection against gas the engine room is pressurized with 15 hp 35,000 cfm axial flow fans. The compound transmission is driven by three quads. It drives the two 8 x 20-inch mud pumps, the 5 x 8-inch washdown pump, two 60 cubic feet per minute air compressors, and the drawworks and rotary. A twin engine unit drives the 7 x 12-inch mixing and standby pump. Two 100 kw 230/115 volt dc generators direct driven by diesels furnish the electric power and light. Two 3.75 kw 230-volt dc/115-volt ac converters furnish what little ac is required.



Deck plans of the barge, showing interior of hull (bottom), machinery deck (center), and quarters deck (top).

On the upper deck are complete living accommodations for 46 men. The quarters are equipped with glass wool insulation against heat and sound. Included are two 8-ton units for air-conditioning, a food freezing room, and a cold storage room. The relatively small open tanks with automatic level control for drilling water and salt water stand just behind the sand reel. The two 5-ton, 50-foot crane booms are controlled by air-driven hoist engines. The 136-foot galvanized derrick is specially designed to withstand 100-mile winds without guys. The latest blowout equipment is installed.

The site of the first well to be drilled



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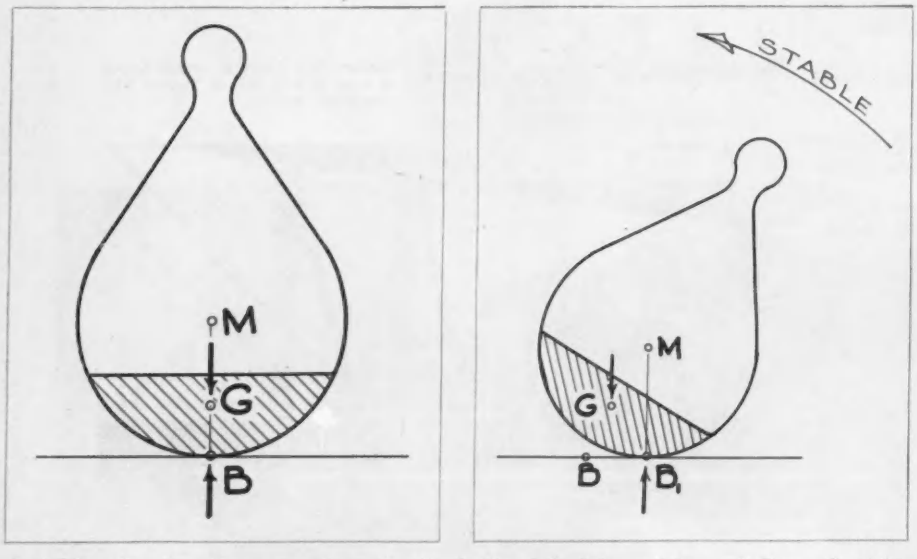
by the new rig was investigated beforehand and found to be typical of the Gulf Coast bottom: a few feet of sandy crust above 20 to 50 feet of silt. A surplus LSM was sunk near the well site to serve a twofold purpose; it gave a general idea of allowable bearing pressures and after the barge arrived served as a breakwater for waves from the southeast. The 204-foot hull of the LSM, its structural steel and hull plating furnishing a dead weight of about 480 tons, broke through and sank over three feet into the bottom after it had been on location a few months. This breakthrough was deliberately avoided with the drilling barge. The barge, with higher ratio of dead weight to bottom area, stayed on location for four months while drilling to 10,906 feet without moving appreciably along or into the bottom and without inclining in any direction more than one-tenth degree. During this time on the first well several storms occurred in which the peak wind velocities reached 70 miles per hour. It is of interest that at optimum bottom loading more of the dead weight is supported by hull buoyancy than by bottom reaction. This control of bottom loading was accomplished by the daily attention of the engineer charged with ballasting of the hull.

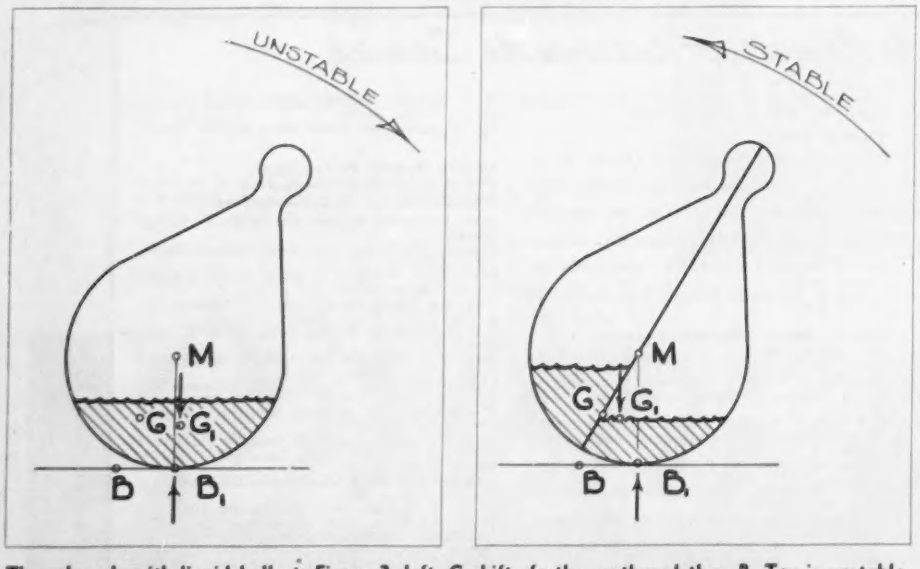
By means of an air-operated telemetering system terminating in the control room the engineer reads fluid weights per unit area of each large tank. Sea water ballast is changed to compensate for changes in fuel, fresh water, dry mud, pipe rack load, etc. While submerged, a proportionate part of the barge weight is carried by the bottoms of the relatively light pontoons. The pontoon loading, accomplished through hydraulic rams, is indicated and adjusted in the control room.

Everyone was agreed that by one way or another the barge would reach bottom, but there was considerable skepticism regarding its being raised to the surface right side up. In bringing up lower and much more stable shallow water barges, men and tools had been thrown overboard, it was said, and a boiler barge had overturned. Breton Rig 20's hull was prepared for raising by circulating water through the six symmetrically located holes in the hull bottom. These lines to the bottom lead into the pump room and are connected to a water supply of limited pressure to avoid blowing in the bottom. High electrical currents were kept flowing to the barge through the cathodic protection system so that the colloidal mud particles would be repelled, as in the Hayward method for unsticking pipe and casing. The actual raising of the barge from flat on the bottom to well above the surface was accomplished smoothly in about an hour. Only by control room instruments was motion noticeable; there was no sudden break from the bottom, no leap to the surface.

The feasibility and practicality of Breton Rig 20 before it proved itself have certainly been controversial subjects. In all its different stages of construction and operation, even technically interested visitors have left the barge with clouded notions as to just how this massive structure can be balanced so high in the air and just what functions are performed by the pontoons. To be anywhere nearly complete, a discussion of how this was planned will necessarily leave the realm of the oil business entirely for that of naval architecture.



A child's roly-poly with center of gravity fixed. Figure 1, left, upright, and Figure 2, right, heeled. When heeled, B_1 is farther outboard than G, and toy is stable.



The roly-poly with liquid ballast. Figure 3, left, G shifts farther outboard than B. Toy is unstable. Figure 4, right, with a centerline bulkhead, shift of G is decreased, and toy is stable.

Stability

A critical examination of the stability of Breton Rig 20 in the floating position can profitably be prefaced by the examination of a simple similar device—a child's roly-poly. The roly-poly of Figure 1 consists mainly of a solid weight in the form of a spherical segment having its center of curvature at M, its center of gravity, G, vertically below M but above the point of support, B. Here we have a situation similar to the new barge where the center of gravity, G, is a substantial distance above the center of buoyancy, B. We all know that if the roly-poly were made to lean over by a push to the side it would not fall further but instead there would appear a tendency to right itself. This ability to right itself from a heeled position is called stability in terms of naval architecture. The action required to heel it is called heeling moment, and the

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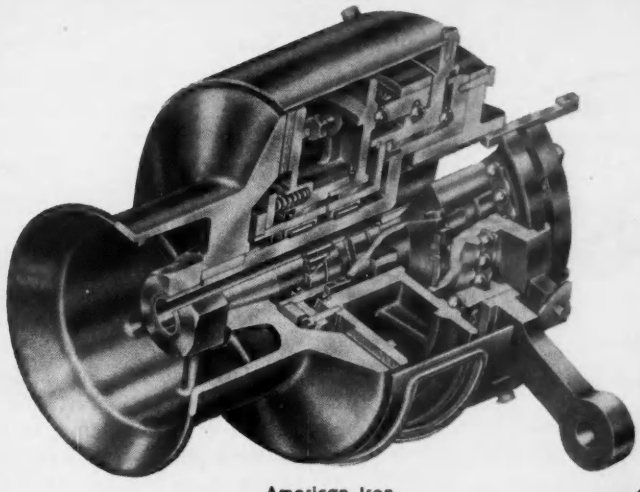

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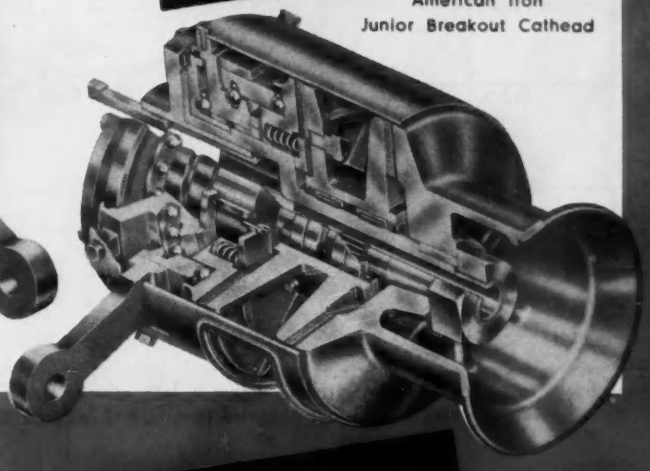

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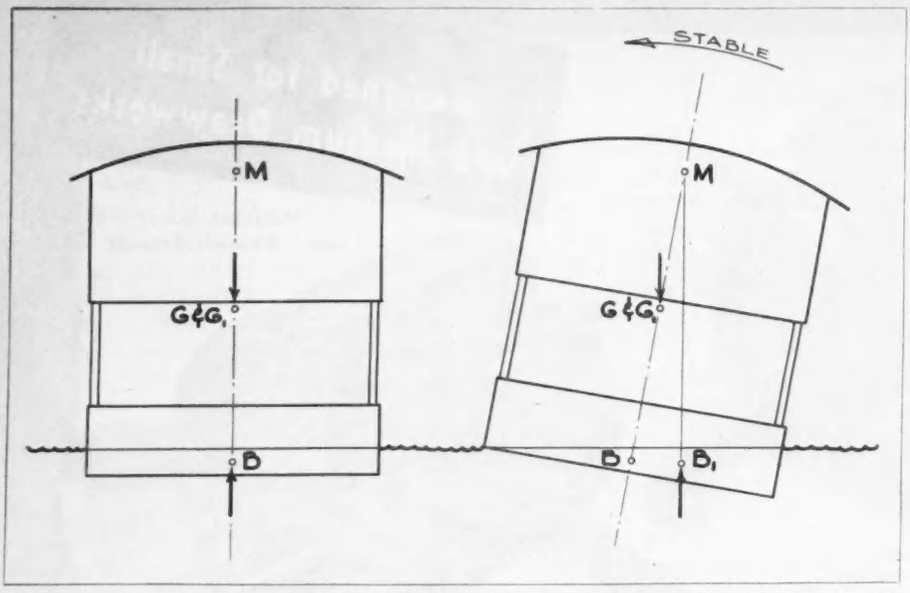
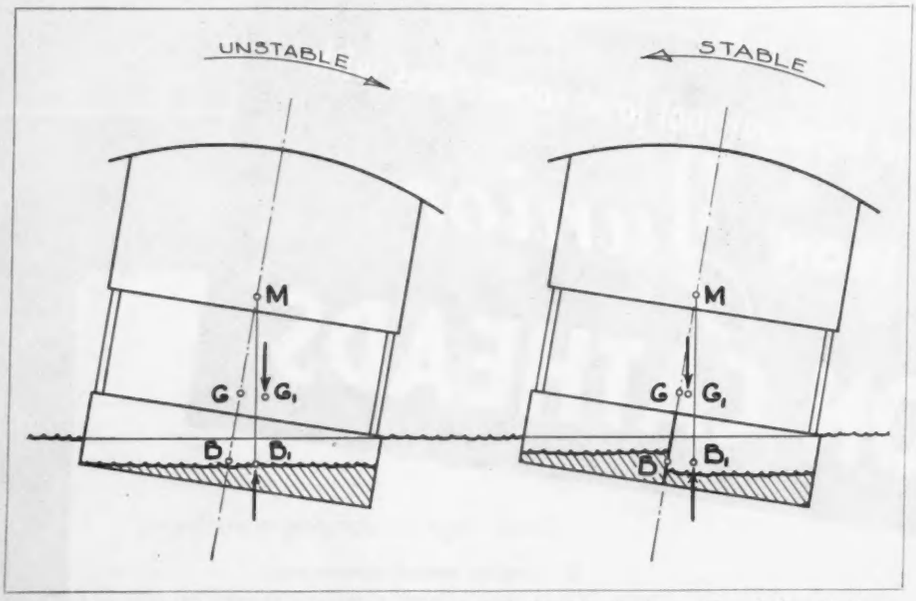
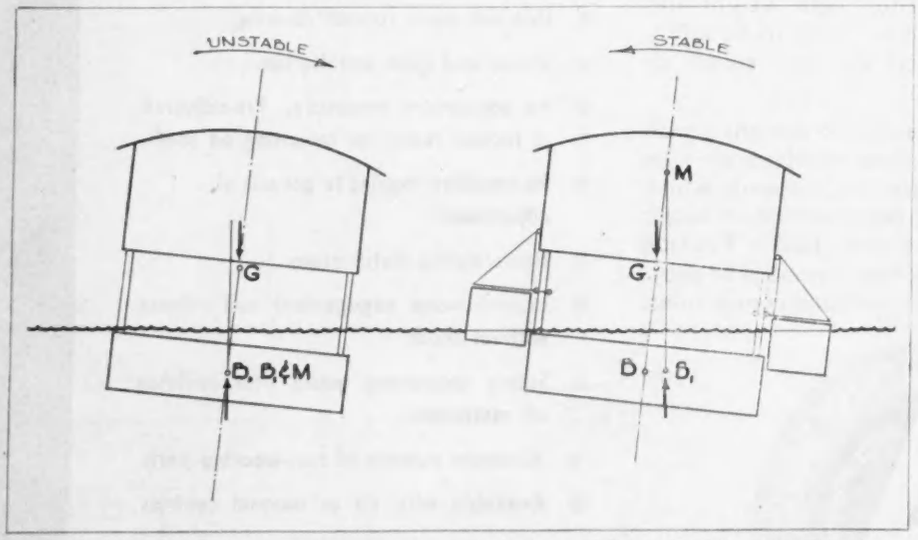


A drilling barge with center of gravity fixed. Figure 5, left, upright, and Figure 6, right, heeled. When heeled B is farther outboard than G, and barge is stable.



Barge with liquid ballast. Figure 7, left, as barge heels G shifts farther outboard than B. Barge is unstable. Figure 8, right, a centerline bulkhead decreases shift in gravity and barge is stable.



Barge at point of total submergence before touching bottom. Figure 9, left, without pontoons center of buoyancy remains fixed, and any degree of heel causes a capsizing moment. Figure 10, right, with pontoons at waterline buoyance shifts with heel, and barge is stable.

equal and opposite reaction of the object itself is termed righting moment.

Figure 2 shows the roly-poly heeled over. Now we can see the source of the toy's stability—the relative position of the vertical forces has changed. Although the support still acts through a single point, this point has moved over in the direction of heel. In its new position the point of support is not just under the center of gravity as it was in the neutral position, but has actually moved beyond, forming a couple with the weight, thus providing a righting moment. By virture of the spherical bottom of the roly-poly, the vertical component of the reaction at B always passes through the same central point, M, thus making it a salient point in the analysis.

Water Ballast

Note further (Figure 3) that if the weight had consisted mainly of water instead of a solid, the center of gravity of the water would have shifted also, passing beyond B, and the righting tendency would have been lost. This loss or reduction of stability due to "free surface" can be substantially prevented by dividing the water-filled space into small compartments, as shown in Figure 4, thus preventing the large shift in G. It can now be seen that a criterion for stability is not that the center of gravity lie below the point of support—a physical impossibility in this case—but that the center of gravity must stay inboard of a perpendicular through the new point of support.

The trick of a movable point of application for the vertical reaction is also accomplished by ship-shape hulls. A cross section of the barge for the neutral position is shown in Figure 5, and for the inclined position in Figure 6. For this discussion the effect of the slot and rakes is negligible, so the hull may be considered a symmetrical rectangular box. For the heeled position the angle giving a triangular submerged area was purposely chosen for easy determination of the new center of buoyancy at the one-third altitude point, the center of triangular area. Actual submerged volumes in the neutral and heeled positions are equal.

When the barge is at the location where it is to be set on bottom, there is a lot more to it than "just open the seacocks and let her sink," or "pump her out and let her rise." During partial submergency there will be many partly filled compartments. A tank partly full of water (said to have "free surface") is a disagreeable passenger. Its center of weight shifts in the direction of heel, thus causing a shift in the center of gravity of the barge, and reducing or

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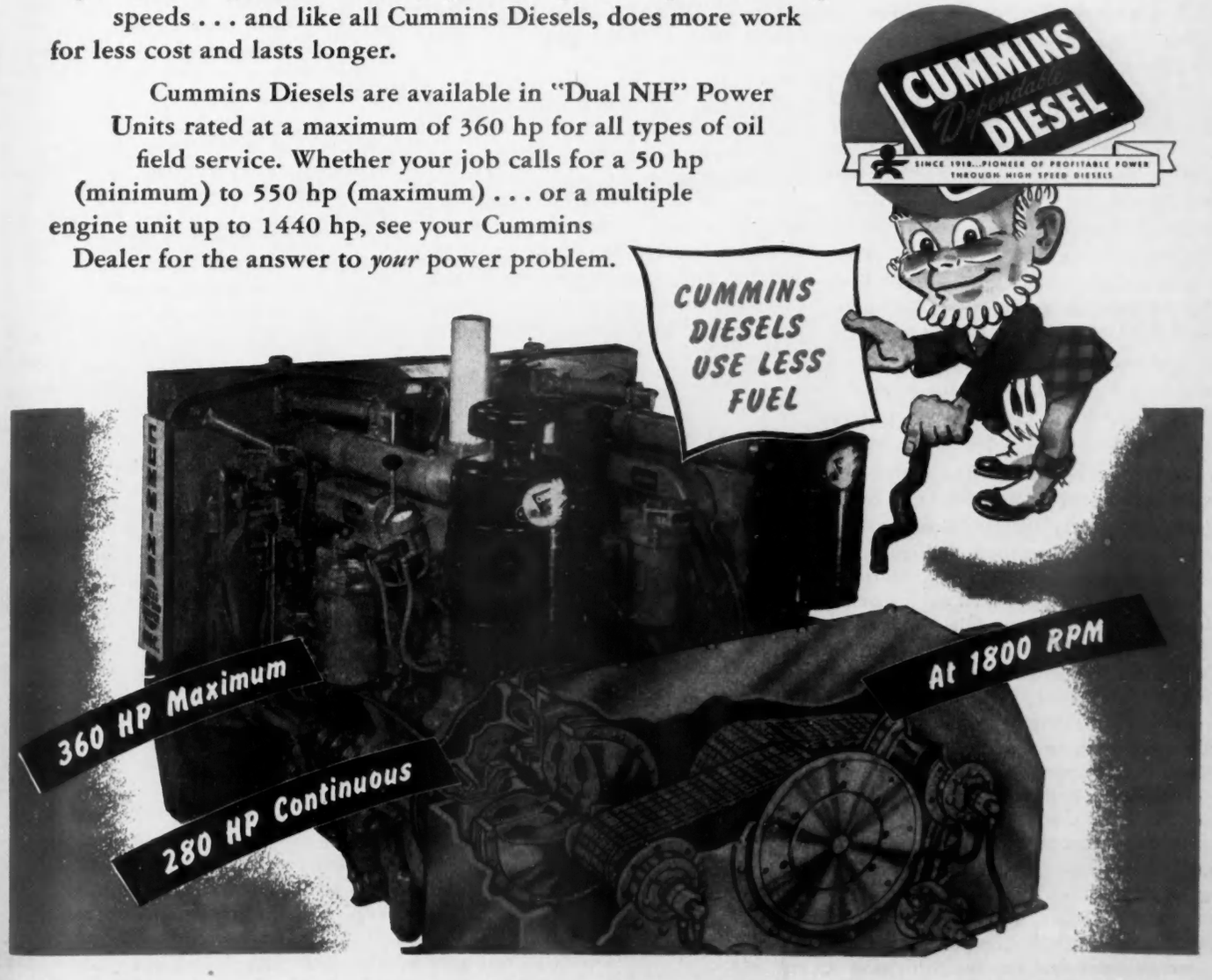

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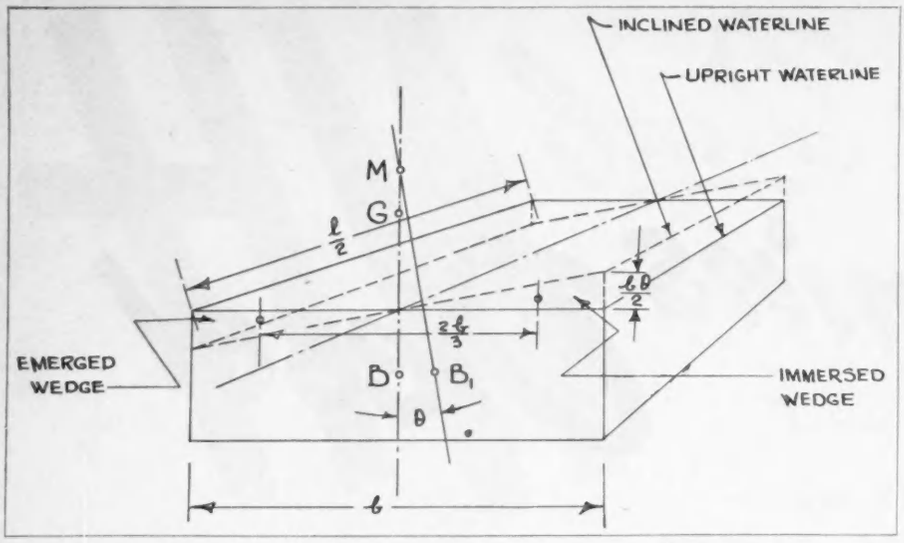

FIGURE 11.

destroying stability as shown in Figure 7. The adverse effect of free surface is reduced by compartmentation, as shown in Figure 8.

The reader may be interested in performing an enlightening experiment showing the effects of the free surface. Put an empty cigar box, cover side up and closed, in a basin with sufficient water to float it. Place a weight like a big spoon along one of the long outer edges and note that the angle of heel due to the heeling moment is barely noticeable. Now fill the cigar box half full of water and again float it. When the weight is replaced at the edge the angle of heel will probably be so great that the weight will slide into the water.

A further problem arises during the submerging operation when the barge loses all stability against heeling just as the water closes over the hull (Figure 9). Stability is dependent on a shift in center of buoyancy caused by a gain in buoyancy on the low side and a corresponding loss in buoyancy on the high side when the barge is heeled. Thus the initial stability vanishes when there is no longer considerable area at the waterline. When the submerged barge heels, there is no increase in buoyancy on the low side, nor is there a loss of buoyancy on the high side. To add to the difficulty, the loss of waterline area also makes the barge unstable so far as its vertical position in the water is concerned. With its deck awash a little added weight will not just sink it a small amount further, but will cause it to go all the way to the bottom.

The primary function of the pontoons is to solve both of these stability problems by providing the necessary waterplane area during sinking and raising (Figure 10). When not serving this prime purpose they rest on the bottom where, by means of four 150-ton hydraulic rams, they share in distributing the bottom loading and guard against undercutting by water currents.

The position of M is derived by noting that the transference in the center of total buoyancy from B to B_1 is caused by a transference in a part of the buoyant volume from the position of the emerged wedge to the position of the immersed wedge. For small angles of heel the sine, tangent, and angle itself expressed in radian measure are taken to be equal. The volume of either wedge becomes $\frac{1}{2} \cdot \frac{b}{2} \cdot \frac{b}{2} \cdot \theta \cdot l$. The transference of center of wedge volume is $\frac{2b}{3}$. The transference of center of buoyancy from B to B_1 is $BM \cdot \theta$. Equating the two expressions for the moment of transference, we have:

$$BM \cdot \theta \cdot V = \frac{2b}{3} \cdot \frac{b^2 l \theta}{g}$$

$$BM = \frac{b^3 l}{12} \times \frac{1}{V} = \frac{I}{V}$$

$$GM = BM - BG$$

where I is the second moment of area, the so-called moment of inertia of the waterline plane in ft.^{4},

V is the displaced volume in ft.^{3},

l is the length in feet,

b is the beam in feet,

Δ is the displacement in tons

θ is the angle of heel in radions

GM is the metacentric height in feet.

The correction to BM and hence to GM for free surface is found in a similar manner to be $\frac{i}{V}$, where i is the moment of inertia of the tank surface about its own centerline axis, and V is the displacement volume of the whole barge. Both transverse and longitudinal values of GM must be determined.

The final position of G for the barge with everything in place would have been much too wearisome to calculate. It was estimated for design purposes and later determined experimentally for the finished barge by means of an inclining experiment in which a known heeling moment was applied and the heeling angle measured. Many readers will recognize metacentric height GM as one of those pitfalls in precision where a most important value is a small difference between two large numbers, with relatively large corrections due to free surface thrown in, it is understandable how a Japanese warship built from stolen British plans capsized during trials.

Future Developments

As a development of a new product, Breton Rig 20 has now reached its climax . . . the completion of the whole cycle of operations of the first model from towing to submerging, drilling, and raising. It is at this time in any development that many of the methods become obsolete. They are still sound, practical, and useful, but the data available only by the use of the first model itself lead to refinements and further inventions. Later barge designs on the drawing board using this new knowledge are quite different from the present rig, satisfactory though it is.

About the Author

PAUL WOLFF, M.E., Stevens Institute 1938, M.S., Harvard University 1940, began his engineering career on the manuscript of the Fourth Edition of "Mechanical Engineers' Handbook" as assistant to L. S. Marks. In 1940 while with Well Surveys, Inc., his first patent was issued on improvements in oil well super-structures. During the war he was associated with the late W. Starling Burgess, famous naval architect and yacht designer, doing work on stability control of damaged naval ships. While acting as consultant on the Barnsdall-Hayward barge he was on leave of absence as assistant professor at Stevens Institute of Technology, Hoboken, N. J.

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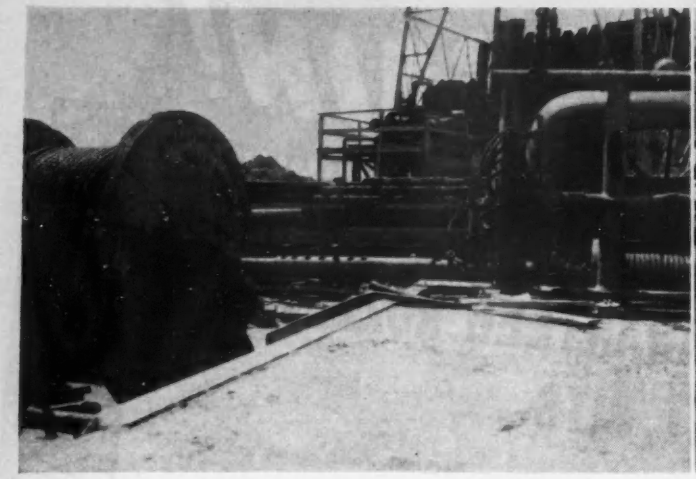

FIGURE 1. View showing manner in which heavy spool of wire rope is attached to shaft of truck winch for power spooling of wire line. Note small steel spool, chain and steel grips, these features providing means by which solid connection is made between spool and pipe axle.

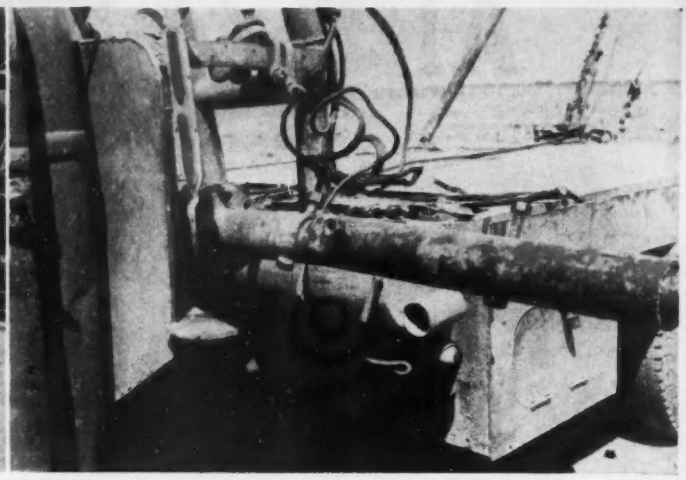

FIGURE 2. Close-up view of truck winch connection. Only modification necessary was the welding of a salvaged flange member to the winch shaft, the telescoping sleeve connection providing a flexible and easily made connector between spool and truck. Seven-eighths inch bolts pin the sleeve sections together.

Truck Winch Take-Off *Speeds* Wire Rope Spooling

By GILBERT M. WILSON
Staff Writer

THE problem of spooling and handling a 3000-foot spool of wire rope, which in the larger diameter lines may have a gross weight of four to five tons, is a common one, and various methods have been devised to simplify the job. An ingenious method of power spooling the heavy reels, one which requires little in the way of special equipment or fabrication, is illustrated in accompanying photographs.

Method of Turning Spool

The spool is slung on a conventional, two-legged rack made of pipe materials, a common type of support employed in the oil fields. The method of turning the heavy spool, however, is to be found in the unique connection and shaft arrangement by which the spool is turned by a take-off from the winch of a field truck, the latter being stationed beside the spool when it is necessary to spool line. The equipment and connections between the spool and truck are relatively simple and can be made up in any welding shop. It is designed so that it is unnecessary to spot the truck at any fixed distance away from the spool, it being necessary only to make sure that the winch shaft of the truck is aligned fairly well with the axle on which the spool is slung.

Key to the success of this particular installation is the manner in which the spool is locked to the 3½-inch outside diameter pipe shaft serving as the spool axle. As can be seen in Figure 1, the axle on the power take-off side of the spool projects beyond the rack for about two feet. Locked on this shaft, between the spool and the yoke or bearing atop the rack leg, is a small steel spool having an outside or flange diameter of eight inches. Inside this spool is a pair of steel eyes, welded diametrically opposite each other between the side plates of the spool.

FIGURE 3. To assist in controlling speed of the spool when line is pulled off, this small brake was mounted on the opposite end of the spool shaft. Brake shoe is a short section of pipe which fits over the 3½-inch O.D. axle. Hook feature provides means of disconnecting and removing brake when spool is being mounted on or removed from rack.

The solid connection between the wire rope spool and the shaft is accomplished by running a length of chain through the steel eyes and attaching it to two steel grips, the later being positioned diametrically opposite each other on the outer rim of the wooden spool. The grips, made of three-eighths inch steel plate, have a wide bearing surface on the rim of the spool. Large holes burned through the connecting end of the grips facilitate the looping and securing of the chain. After the chain is pulled up hand tight, a load binder is employed to take up any remaining slack. When the chain

■ CONTINUED ON PAGE 105

Drilling Accidents Analyzed

EVERY oil well drilling contractor is or should be aware that frequency and cost of accidents occurring to both his employes and those working for other contractors are governing factors in the raising or lowering of workmen's compensation insurance rates. It is always desirable, of course, to see one's rates reduced but it is seldom that a contractor can expect this if he is the type of employer who views accident prevention with an air of complacency. Contractors assuming this attitude are definitely in the minority but unfortunately their failure to correct certain hazards and work practices has a direct bearing on the insurance rates more conscientious contractors must pay. Moreover, they burden themselves with a handicap in a highly competitive business.

This discussion of 6133 drilling accidents, presented as a cross section of the accident problem, has been prepared with a strict regard for facts. The information came directly from employers' accident reports. Accident categories are treated in the order of descending costs as shown on the accompanying chart.

Struck By . . .

All accidents in this category follow the same general pattern. Each man was struck and injured by some object which slid or swung against him, toppled over or contacted him in some other manner. Accidents involving objects which fell or flew freely through the air are excluded, as are those resulting when a man was struck by a moving part of any machine. There follows a breakdown of the agents of injury involved in these 1026 struck by . . . accidents.

Agent of Injury	No.	Cost
Tongs	280	$54,682.96
Tubing, Casing, Drill Collars, etc.	223	49,259.73
Rope, Chains, Cables, etc.	183	27,023.76
Others	340	83,094.46

About half of the men injured by tongs simply failed to get out of the way when units were in normal use. Thirty-six workers were struck when tongs "caught and jerked back," when tongs were unexpectedly or prematurely pulled by catheads, or when lines fouled or "balled up" in catheads. It is difficult to say here how much of the fault rested with human negligence. Several reports stated that something went wrong with automatic catheads which engaged and pulled the tongs. Eighty-four men were injured due to one of the following causes: snub or jerk lines broke, tongs slipped on pipe, tong latches broke, tongs broke, cable pins came out.

The accident pattern involving tubing, casing, drill collars and similar equipment was clear. Briefly stated, the majority of the workers injured while handling these units were struck because of their own negligence. One man lost his life when he was struck by a drill collar suspended from a catline.

Of those accidents involving ropes, cables and chains, spinning lines were the most prevalent agents of injury. Most of the men so injured did not accord themselves a sufficient margin of safety when spinning lines were in use. There were, however, many accidents resulting from material and mechanical failure as well as the misuse of equipment, such as the overloading of lines. A catline fouled and broke a spinning chain; a winch line broke, snapped back, and struck a worker. Add a broken rotary chain and a contractor will have the picture.

The 340 accidents designated as "others" involved so many objects that it would be wordy reading to name them. Bits, beams, timbers and handles of "backup" wagons are a few. It was found that the injured men were mostly engaged in loading, unloading or other handling of material. A chain hoist was being used to unload a kelly joint when the hoist slipped and caused the joint to strike and kill a man. While helping other workers move some bulky equipment a second man was struck and killed by a heavy beam.

Caught In, On, Or Between

This accident category offers some interesting particulars. Caught in . . . accidents ranked first in number and second in cost in this study. Of the 1134 accidents so classified, 1000 resulted in arm-hand injuries. These injuries accounted for almost three-fourths of the caught in . . . cost. When a count was made of the activities in which men engaged at the time of injury, it was found that 965 of the 1134 were handling equipment and material during the normal procedures of going into or out of the hole. Following are agents of injury most closely associated with these accidents.

Agent of Injury	No.	Cost
Tool Joints, Casing, Drill Pipe, etc.	272	$41,017.33
Elevators	225	32,979.55
Winch Lines, Spinning Lines, etc.	119	32,984.80
Tongs	205	21,733.59
Others	313	43,282.51

Of those men injured by casing, pipe and similar equipment, all suffered arm-

THIS ARTICLE was prepared by the Safety Engineering department of the Texas Employers' Insurance Association. It is based upon 6133 accidents reported by Texas contractors during 1946 and 1947. These accidents cost $1,088,026.50 in compensation and medical payments. It is believed that these accidents are a representative cross-section of drilling accidents in Texas and elsewhere. All information is concerned primarily with the operations of rotary rigs.

hand injuries except 49 workers who sustained injuries to other parts of the body. Of the latter number, 27 were foot injuries. As examples of the majority of arm-hand injuries, these instances are cited: A worker was assisting in laying down a joint of drill pipe when one of his fingers was caught beneath the pipe and severed. A second man was engaged in removing pipe from a rack when his arm was caught by the pipe in some manner and the arm was broken. Of the foot injuries, these examples will serve: Pipe was being lowered while the crew was going in the hole and one man's foot was caught beneath the pipe. The foot and ankle were fractured. Under like circumstances another worker lost the toes on one foot.

Pertaining to elevators, each man was handling this equipment when he was injured. In the order of frequency, these men were caught between elevators and pipe, in elevator latches or other pinch points, and between elevators and various other objects. Injuries followed the usual pattern of caught in . . . accidents, that is, finger amputations, fractures, and severe cuts. Only seven injuries were not of the arm or hand. Of these seven, four were foot injuries, the most serious of which concerned an employe whose foot was crushed when it was caught between an elevator and slip.

Tong accidents followed a pattern similar to mishaps involving elevators. Most of the injured men failed to remove their hands quickly enough while latching tongs and were caught. In other cases, the men were caught between tongs and pipe, between two pairs of tongs and between tongs and some other object. The expected amputations, fractures, and cuts resulted.

From the standpoint of the over-all cost of injurious agents involved in caught in . . . accidents, those concerning winch lines, spinning lines, and similar equipment were second, excluding miscellaneous items. But from the standpoint of the individuals who were injured, these agents proved the most damaging accidents, causing the most painful injuries. Each accident averaged $277.18 in compensation and medical costs. All but a few of the men here concerned suffered arm-hand injuries. Spinning lines were the chief bugaboo for reasons every contractor will understand without further comment. Men who were caught in various cables or ropes peculiar to drilling operations made up the remainder of those injured.

In the miscellaneous category, workers were caught between swivels and bails, in blocks, and in or between almost every other type of equipment or material not already mentioned.

In this category we are concerned only with those objects which for any reason whatsoever fell freely through space, however limited the distance, and struck a worker. In order to identify the circumstances under which falling objects occurred, the following classifications were prepared:

Agent of Injury	No.	Cost
Suspended Objects	141	$55,625.91
Free Falling Objects	71	46,172.33
Manually Handled Objects	218	31,185.41
Others	99	24,198.43

The unusual and the commonplace accompanied suspended objects which fell. Casing slipped from elevator latches; a tong line block fell and killed a man. Human negligence as regards personal safety as well as equipemnt which was obviously faulty were the basic causes of these accidents.

By free falling objects is meant those which were not beforehand held in place by any kind of line, chain, or cable. Those objects which fell and injured men included wrenches, chisels, and other other tools left in the derrick as well as nuts, bolts, thribble boards, and even derrick braces. Almost half of the accidents in this classification involved thribble and finger boards, a number of which had been knocked loose by equipment moving in the derrick. From re-

Oil Well Drilling Accidents Classified by Type and by Agents of Injury

	STRUCK BY				CAUGHT IN, ON, or BETWEEN					FALLING OBJECTS			
TYPE OF ACCIDENT	Tongs	Casing, Tubing, Etc.	Cables, Chains, Rope, Etc.	Others	Drill Pipe, Tool Joints, Etc.	Elevators	Spinning Chains, Winch Lines, Etc.	Tongs	Others	Suspended Objects	Free Falling Objects	Manually Handled Objects	Others
No. of Accidents	280	223	183	340	272	225	119	205	313	141	71	218	99
Cost	$54,682.96	$49,259.73	$27,023.76	$83,094.46	$41,017.33	$32,979.55	$32,984.80	$21,733.59	$43,282.51	$55,625.91	$46,172.33	$31,185.41	$24,198.43
Percent of Total No.	16.7%				18.5%					8.6%			
Percent of Total Cost	19.6%				15.8%					14.4%			

	FALLS FROM HEIGHTS						OVER-EXERTIONS	MACHINERY						
Type of Accident	Immediate Working Surfaces	Above Derrick Floor	Riding Elevators	Various Equipment	Structures	Others	Mostly Lifting	Catheads	Clutches and Brakes	Belts and Pulleys	Cranking Motors	Radiator Fans	Chains, Sprockets, Gears	Others
No. of Accidents	132	17	7	21	19	24	583	25	76	39	39	26	17	44
Cost	$55,182.35	$26,371.96	$18,116.00	$10,386.51	$ 7,445.15	$ 7,995.91	$103,519.82	$33,529.55	$10,499.61	$ 9,936.37	$ 6,440.25	$ 3,934.50	$ 2,441.98	$ 572.65
Percent of Total No.	3.6%						9.5%	4.3%						
Percent of Total Cost	11.5%						9.5%	6.2%						

	FALLS ON SAME LEVEL				TEMPERATURE EXTREMES	TOOLS	FLYING OBJECTS	STRIKING AGAINST	VEHICLES	HARMFUL SUBSTANCES	SLIPS		
TYPE OF ACCIDENT	Water, Ice, Mud, Oil	Stumbled Over Objects	Using Hand Tools	Others	Gas Explosions, Hot Water and Metal, Welding Flashes, Gasoline and Kerosene Burns	Wrenches, Hammers, Hatchets, Crowbars, Etc.	Mainly Hammering, Grinding, Chipping Operations Involving Tools	Nails, Wire, Slivers, Etc.	Mainly Collisions Other Vehicles	Drilling Mud, Acid, Caustic, Etc.	Water, Ice, Mud, Oil, Miscellaneous Objects	MISCELLEANOUS	TOTAL
No. of Accidents	154	87	10	23	253	384	450	359	36	442	119	58	6133
Cost	$34,693.47	$12,990.52	$ 2,585.33	$ 3,720.13	$39,318.67	$38,130.17	$32,028.45	$22,360.76	$21,229.25	$17,064.23	$9,571.45	$14,720.69	$1,088,026.50
Percent of Total No.	4.5%				4.1%	6.3%	7.3%	5.9%	.6%	7.2%	2.0%	.9%	100%
Percent of Total Cost	5.0%				3.6%	3.5%	3.0%	2.0%	2.0%	1.5%	1.0%	1.4%	100%

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ports, some thribble and finger boards had not been properly secured.

As suggested, manually handled objects were those which men dropped on themselves or co-workers. These objects included tools, boards, bits, and a miscellany of other materials. Foot injuries predominated by far, a good argument for the use of safety shoes.

Falls From Heights

Of those accidents which occurred in the immediate vicinity of drilling operations, falls from heights resulted in the most severe injuries on the average and cost the lives of four men. Here are the locations from which men fell.

Location	No.	Cost
Immediate Working Surfaces		
Pipe racks, ramps and runways, steps, derrick floors or sub-structures, through derrick floors, rotary tables	132	$55,182.35
Above Derrick Floor		
Derrick ladders, girts, guard rails, stabbing or thribble boards	17	26,371.96
Elevators (Riding)	7	18,116.00
Various Equipment		
Drawworks, pumps, gin poles, kellys, engine belt	21	10,386.51
Structures		
Engine shed or belt house roofs, tanks, boilers	19	7,445.15
Others	24	7,995.91

For the most part, men fell at those locations designated as "immediate working surfaces" because these surfaces had been made hazardous by oil, mud, and water. Holes in derrick floors were another contributing factor. As for those employes who fell from locations above the derrick floor, it appeared that the employes so injured became accident victims through hazardous acts of their own. One man was killed.

Of long standing controversy has been the subject of riding elevators. Many contractors hold that this practice is safer and more efficient than the use of derrick ladders. However, in justice to the facts, of the seven men who fell from elevators, one was killed and three suffered permanent and crippling injuries.

With reference to men who fell from drawworks, pumps, and the other surfaces or objects named, reports did not contain enough particulars for any specific hazard or hazards to be named. The contractor can draw his own conclusions. One man who stood on a large wrench handle fell and was critically injured. His injuries involved a compensation and medical cost of more than $3500.

Over-Exertions

By "over-exertions" is primarly meant those accidents resulting in muscular efforts causing sprains, strains, and hernias. There is little of the spectacular or the dramatic in a situation like this: A man bends over from the waist, grasps a heavy object, and then attempts to stand erect. At that time, or perhaps later on, he complains of a soreness in his back or abdomen. Believe it or not, injuries occurring in this very way have frequently cost several thousand dollars.

Most over-exertions, just as the term implies, result from the misuse of muscles which were not meant for heavy lifting or other strenuous work. Of all the injuries in this category 479 out of 583 were trunk injuries. These in turn were caused for the most part by acts of incorrect lifting. It is suggested that employers teach correct lifting; it is of vital importance to a man's well-being and to his job. When a man intends to lift anything of appreciable weight, he should bend his knees, stand as close to the object as its size and shape will permit, and with his feet on the same level make the lift straight up with the object held close to his body. If this discussion of the correct way to lift sounds a little dramatic, bear in mind that each of these accidents bore an average cost of $177.56.

Machinery

Should the reader need a good opening remark to impress him as to the seriousness of drilling accidents involving machinery, note this: There were 266 such accidents and 26 percent of them, more than one-fourth, resulted in fractures or amputations. This does not include one man who lost his life and 60 men who suffered very severe flesh wounds. The mechanical units involved follow.

Agent of Injury	No.	Cost
Catheads	25	$33,529.55
Clutches and Brakes	76	10,499.61
Belts and Pulleys	39	9,936.37
Motors (Cranking)	39	6,440.25
Radiator Fans	26	3,934.50
Chains, Sprockets, Gears	17	2,441.98
Others	44	572.65

What drilling contractor or employe does not know of the terrible consequences when a man is caught in a cathead? These accidents followed a very familiar pattern. An operator's arm was caught by the catline and drawn into the cathead. The arm was twisted off just as you would twist a match. There was the case of a cathead operator who allowed himself to work with an old and dangerous hazard, that of letting the catline lie in a loose mass at his feet. He will do this no more for the catline balled up while being drawn into the cathead. The man's foot was entangled in it. He was killed. Worn catlines, grooved catheads and the other hazards which frequently accompany the operation of this equipment have taken and will continue to take lives as long as such hazards exist. The clutch which slipped and the brake control which kicked tell the story of accidents involving these units.

A belt and pulley can become a monster to a man who cleans a grease-gun fitting while wearing gloves. An employe who did this was jerked into a pulley when the belt caught one of his gloves. The same thing happened to a man who for some unexplained reason placed his hand under a belt. There must be mentioned, of course, the employe who wore loose or flapping clothing while throwing a belt, for he too was jerked into a pulley.

There is a question as to whether or not any of these accidents occurred because a particular pulley lacked a guard. Likely enough, some pulleys were guarded but not a single accident report made the definite statement that a pulley involved in any of these accidents had a guard.

The majority of those men who were injured while cranking motors could blame their injuries on the fact that the motors backfired. Although these accidents were small in number the injuries men sustained were not minor in any degree. One-third of these men suffered fractures which were mostly arm injuries. However, a few individuals were struck in the face. One of these suffered a partial loss of vision in both eyes as well as facial disfigurement.

With the exception of three truck radiator fans, the fans previously mentioned were on power units used in drilling operations. These accidents occurred either when a man allowed his hand to come in contact with a fan while cranking a motor or when he was servicing a motor. Four men suffered partial finger amputations and three more sustained finger fractures.

There were six men whose gloves or clothing were caught in a rotary chain, a gear, or a sprocket. The manner of injury to the remaining men in this group was not made clear by accident reports. It is a reasonable assumption that they were simply engaged in the servicing of these mechanical units. One man lost a finger and suffered a broken arm as well while four other men sustained finger fractures.

There were 44 other machinery accidents of a minor nature. It should be pointed out that these machinery accidents resulted almost equally from hazardous acts of a personal nature and because mechanical units were not properly guarded or maintained.

Falls on Same Level

Of the 274 accidents of this type, more than half were due to slipping hazards caused by oil, mud, ice and water. Rough flooring, debris and odd materials created tripping hazards which accounted for some of these falls. There were seven cases involving men who

were using wrenches which slipped and caused them to fall.

Temperature Extremes

The greatest single accident pattern accompanying these accidents involved 69 explosions of gas due to sparks from motors, matches, torches, and cigarettes.

The second most frequent accident pattern concerned workers who were burned by steam, hot water, and hot metal. Welding flashes caused 44 men to suffer eye burns. Men whose clothing had come in contact with gasoline or kerosine, as well as certain solvents, were burned when their clothing became ignited in some manner. One man died in a boiler explosion.

Tools

It is hardly necessary to discuss at length the manner in which men are injured while using wrenches, hammers, chisels, and other tools. The 207 arm-hand injuries, out of a total number of 384 injuries, indicate the slipping wrench and injured arm, the glancing hammer and mashed finger.

Flying Objects

The flying object which strikes and injures a man seldom gets on an accident report unless an eye injury results. Of 450 accidents caused by flying objects, 312 resulted in eye injuries and each of these injuries averaged $71.23 in cost. Hammering, grinding, and chipping operations involving tools frequently offer great danger to a man so engaged when his eyes are not protected by safety goggles. There were 235 cases of flying steel particles alone which resulted from these acts and caused eye injuries. For example, one man's eye was so badly injured that its removal was necessary. Another man lost the sight of one eye when it was penetrated by a steel splinter while he was hammering a pin in a rotary chain.

There were, of course, instances in which both eye and general skin injuries were caused by flying bits of rust, metal grindings, and what accident reports described as "foreign objects." The main point to consider here, however, is the fact that when a steel tool strikes some hard object the eyes should always be protected by goggles. The alternative will always be more cases of blindness.

Striking Against

This is an accident category containing two principal hazards. These are bad housekeeping and a lax regard for personal safety which some employes assume when they are handling objects which are pointed or sharp, such as tin, other metal objects, and splintery boards. Hand, foot, and leg injuries predominated. Most of the foot injuries occurred when men stepped on nails.

Vehicles

The 36 vehicle accidents in this category did not result from direct drilling operations, but they did follow the general pattern of vehicle accidents everywhere. Little is to be gained by citing individual cases, but much is to be gained by pointing out that unsafe driving practices or poorly maintained vehicles can cost drilling operators expensive equipment and men their lives. Collisions with other motor vehicles caused most of these accidents. Seven men lost their lives.

Harmful Substances

The outstanding fact in this category is that 332 out of 442 accidents resulted in eye injuries. Drilling mud containing chemicals was the greatest single agent of injury. Contact with certain paints, caustic soda, acid vapors or acid, and cement accounted for most of the remaining accidents of this group.

Slips

The causes of the 119 accidents in this category resulted from the same hazards as those causing some falls. Briefly, men lost their balance and slipped or stumbled due to mud, water, oil or various tripping hazards caused by a variety of miscellaneous objects. The reader will visualize the instinctive efforts a man makes under these circumstances to keep from falling. He will frequently and violently throw out an arm or leg, twist his body or otherwise subject himself to sudden and severe strain to keep from falling. None of these men actually fell but nevertheless they suffered sprains, strains, and hernias.

With the exception of a miscellaneous group of accidents, we have concluded this anaylsis. Although all fatalities were not mentioned, 16 men were killed and 13 percent of all the injured men were either partially or totally crippled. There is no way to ascertain how much equipment was damaged or ruined or how many thousands of dollars these accidents cost employers. That these factors were present is definite and that the employers had to foot the bill is undeniable.

We have enumerated the "why's" of more than 6000 accidents and assuming a reasonable attitude, it is realized here that many of these accidents could not be foreseen by employers or employes and that their prevention would have demanded almost mystic powers. But in the main, this is true. Men, methods, or materials are present when most hazards are created. Intelligent, constant vigilance is necessary to correct these hazards for when they exist, as this analysis has set forth, accidents are more likely to be certainties, not "maybe's."

Truck Winch Take-Off Speeds Wire Rope Spooling

■ CONTINUED FROM PAGE 98

is tight, the spool, being securely attached to the 3½-inch pipe axle, then can be rotated by turning the shaft.

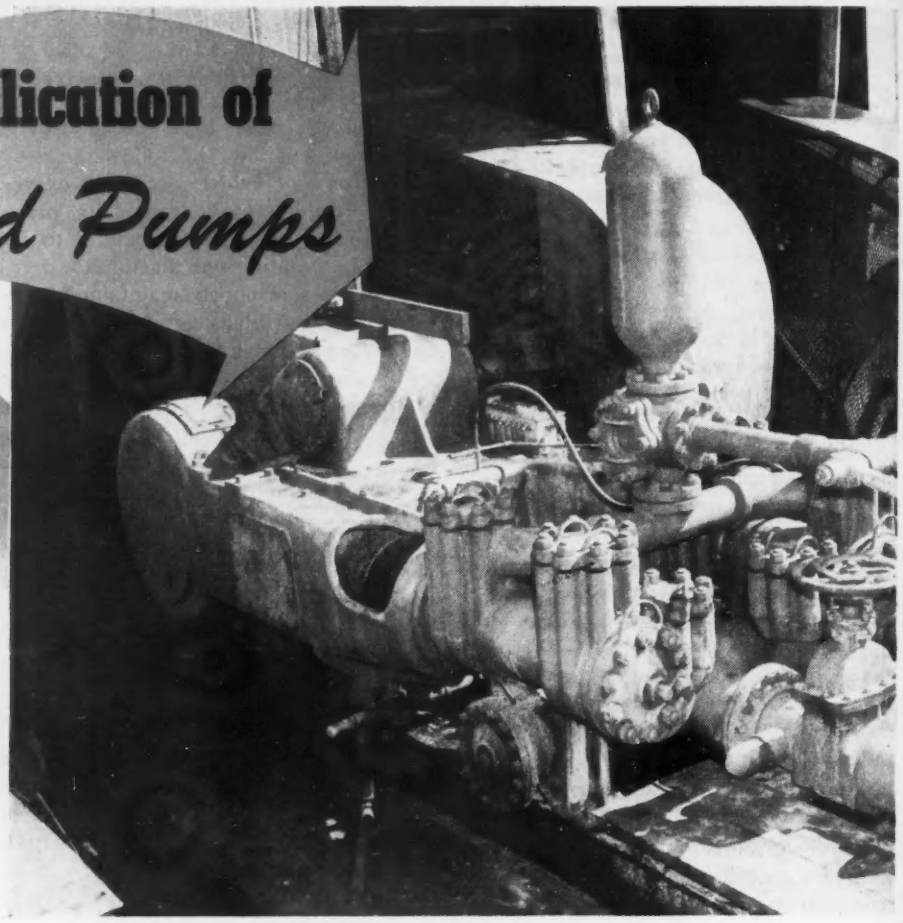
The method of connecting the spool axle to the truck winch shaft is comparatively simple. To the end of the truck winch is welded a special fitting consisting of a bolted flange member and an 11-inch piece of 4¼-inch OD pipe. A short length of 3½ pipe is inserted inside this 4¼-inch nipple, provision being made for the two sections to be pinned together (Figure 2) with a bolt which is run through matching holes in the inner and outer sections. The main drive sleeve connecting the winch to the spool axle consists of a 30-inch length of 4¼-inch OD pipe, the latter having a number of regularly-spaced holes drilled through it to permit adjustments that may be required in connecting the units together. Two ⅞-inch bolts with nuts attached are used to pin the driving and driven members together.

Hand Brake

On the opposite end of the spool shaft is rigged a small hand brake which aids in the control of the spool, particularly when rope is being pulled off and considerable distance separates the rig man and the man at the spool. Shown in Figure 3, the brake consists of a small six-inch wide shoe made from a one-third section of pipe which fits over the top portion of the shaft. To the upper side of the shoe is welded a two-foot steel handle. At the shoe end of the brake handle, which extends several inches beyond the brake shoe, is cut a V-notch which is hooked into a round hole burned out of a piece of flat steel plate welded to the back side of the rack base leg. With the brake shoe serving as the fulcrum, the lever provides ample leverage for the brake operator. The lever easily is removed whenever a spool is mounted on or taken off of the rack.

If care is taken in the design of the rack or base, such a spooling device can be made to handle practically any size or width spool that may be encountered in the field. The use of steel grips and the chain connection provides a positive means of connecting the spool to the axle, enabling the heaviest spools to be turned. Quickly assembled or disassembled, the device easily is transported from one location to another. Although the unit is power driven, there is no need for the truck to be stationed at the well site unless and until it is necessary to spool line, the truck being free to be taken or used elsewhere between jobs.

Application of *Mud Pumps*



By KENNETH N. MILLS
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THE USE OF the mud pump is separated into its components, and graphs presented to show characteristics under varying conditions. Basic data on pumps are evaluated to meet most field applications and allow pump selection and operation to achieve maximum results.

MUD performance can have a material effect on the rate of penetration in all but the hardest formations. Analysis of drilling time breakdowns on average formations indicates the largest percentage of controllable drilling time is spent rotating the drill pipe. Improvements in drilling bits, drill pipe and drilling technique should increase this percentage in all formations. Recent investigations have shown that, in all but the hardest formations, the rate of penetration varies with the rate of circulation and increases as the rate of circulation is increased. As drilling costs are primarily a time function, the proper selection and utilization of slush pump capacity can be important factors in reducing drilling cost, because they increase the rate of penetration.

To properly apply a slush pump to the drilling operation, it is necessary to understand the functions of mud in the rotary drilling process. In addition to controlling formation pressures, the drilling mud removes cuttings from the hole and helps clean and cool the bit. In soft formation drilling, it has been shown that it can be used to break up the cuttings as they are formed, and materially increase the rate of penetration. This use of drilling mud requires bits with special water course designs. The bit designs, results obtained and operating technique covering their use of drilling mud are covered in two papers by Nolley, Cannon and Ragland.[1, 2]

As one of the primary purposes of mud in the rotary drilling process is to remove cuttings from the hole, this should be one of the basic considerations in determining the rate of circulation. The theoretical considerations involved in the lifting of cuttings from the hole were defined by J. S. Piggott.[3] The rate at which cuttings are carried up by the mud is a function of the mud viscosity, mud density, mud velocity in the annulus and the size and shape of the cuttings. Piggott gives some tabular values of cutting slip velocity for two types of cuttings, as shown in Table 1. In this table it will be noted that slip velocity increases as the size of the cutting increases and it is higher for round cuttings than for flat cuttings. The slip velocity decreases as the mud viscosity or density is increased, but increases in each of these mud properties increase the circulating pressure. The relationship between the slip velocities of round and flat cuttings is fortunate, because most round cuttings are relatively small as they are cut from sand or other hard formations, and are not usually larger than 0.063 inches in diameter. Practically all cuttings from consolidated formations are flattish in shape and consequently are easier to remove from the hole with moderate return velocities. Cuttings too large to be lifted at the velocities existing in the annulus must be re-cut by the bit until their size has been reduced sufficiently to permit them to be carried up by the mud stream. If the concentration of these large cuttings at the bit is too great, the bit will "ball up," and drilling progress will stop. The fact undoubtedly accounts for the extremely high rates of penetration obtained when using high bit nozzle velocities in soft formation drilling to

disintegrate the cuttings. This practice should produce a material reduction in the size of the cuttings and increase the efficiency of the mud as a chip conveyor. This reduction in cutting size should decrease the possibilities of sticking the drill pipe, because it decreases the tendency for cuttings to concentrate at a point of low velocity in the annulus. If the hole contains caved spots which increase the area of the annulus and decrease the mud velocity to a value less than the slip velocity of the larger cuttings, these cuttings will concentrate in this zone of low velocity. If this concentration should become sufficiently high, it could cause the drill pipe to stick when circulation is stopped, as all of the cuttings accumulated would fall into the smaller section of the hole. As the use of high bit nozzle velocities causes a material reduction in the size of the cuttings, it should help prevent the occurrence of this type accumulation of cuttings.

High Return Velocities

From Table 1, it is obvious that the spread between return velocity and cutting slip velocity increases, as the return velocity is increased. This would suggest that the problem of effective removal of cuttings might be solved by using high return velocities in the annulus. While the practice does result in more efficient cutting removal, if carried to an extreme, it will materially increase the pressure imposed on the formations being penetrated. Also, it will increase the abrasion on the mud cake covering the hole wall and materially increase the pump pressures. In a paper by Beck, Nuss, & Dunn[4] attention was called to the fact that high pressure drops in the annulus could cause loss of mud to the formation while the mud is being circulated, and the well would be in danger of blowing out when circulation is stopped. This was explained by the fact that the pressure drop in the annulus due to the fluid friction could approximate the difference between the formation and overburden pressure. When circulation is stopped, this difference would disappear and the well would attempt to blow out. An obvious solution to this problem is to control the return velocity and the mud properties to assure a low pressure drop in the annulus. It is one major operator's practice in soft formation drilling to use a return velocity in the annulus between 175 and 200 feet per minute. When drilling hard formations where the maximum cutting size will be small, it is reasonable to assume that lower return velocities can be used. The return velocity will depend on the rate of circulation and the area of the annulus. The return velocities for various hole and pipe sizes can be determined from the alignment chart shown in Figure 1. The use of the chart is illustrated by the example lines shown on the chart. If the hole and pipe sizes are known, draw a straight line through these points which will intersect the turning axis "X." A straight line from this point on the turning axis through the desired return velocity value will intersect the pump output scale "B" at the pump output value required for this return velocity.

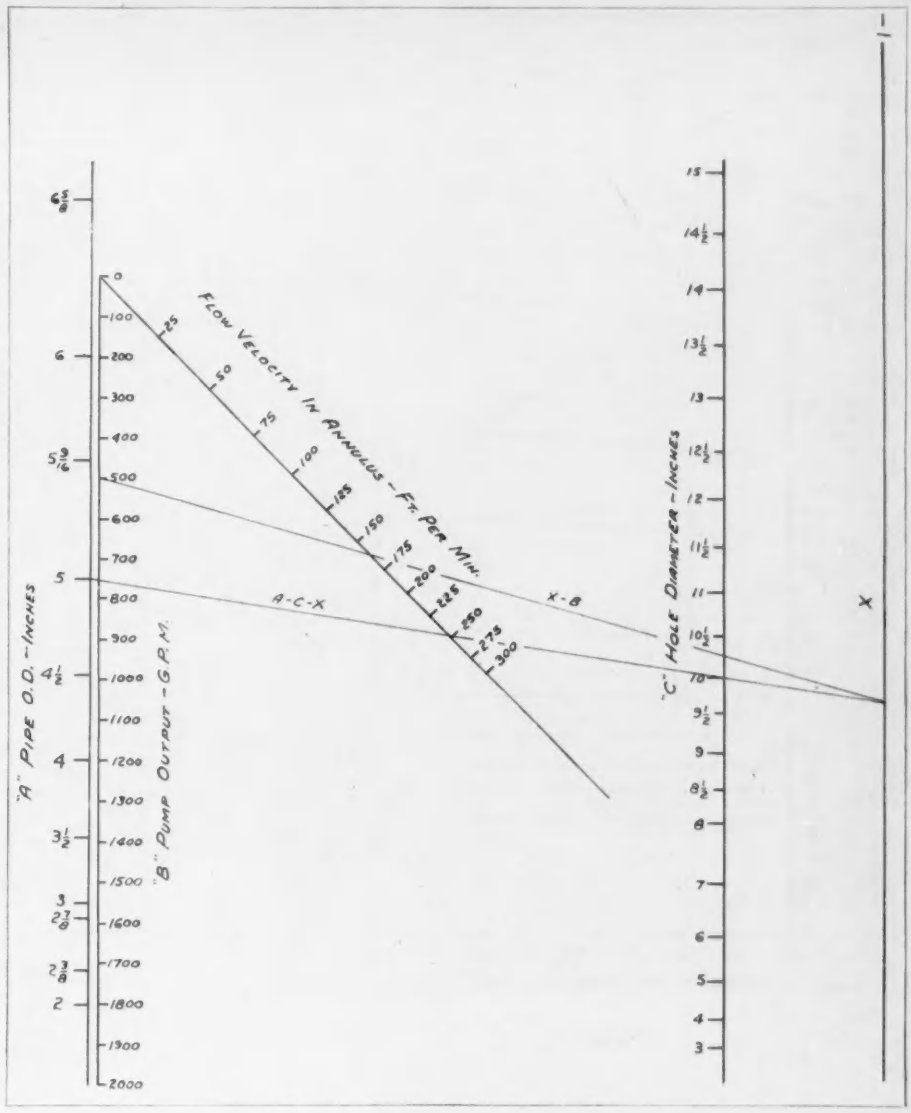

FIGURE 1. Return velocity chart.

TABLE 1

Mud Velocity Ft. Per Min.	Feet Per Sec.	SLIP VELOCITY OF CUTTING FT./SEC. Diameter of Cutting—Inches 0.50	0.25	0.125	0.063	0.031
ROUND CUTTINGS						
6	0.1	0.07	0.018	0.004	0.001	0.000
18	0.3	0.21	0.054	0.013	0.003	0.000
30	0.5	0.35	0.090	0.022	0.006	0.015
60	1.0	0.70	0.180	0.044	0.011	0.003
120	2.0	1.39	0.350	0.086	0.022	0.006
180	3.0	1.85	0.510	0.130	0.032	0.008
240	4.0	1.85	0.670	0.170	0.042	0.011
360	6.0	1.85	0.960	0.240	0.060	0.015
FLAT CUTTINGS						
6	0.1	0.027	0.007	0.002	0.000	0.000
18	0.3	0.081	0.021	0.005	0.000	0.000
30	0.5	0.135	0.035	0.008	0.002	0.000
60	1.0	0.270	0.070	0.017	0.004	0.001
120	2.0	0.540	0.140	0.033	0.008	0.002
180	3.0	0.72	0.200	0.048	0.012	0.003
240	4.0	0.72	0.270	0.065	0.016	0.004
360	6.0	0.72	0.380	0.094	0.023	0.006

Maximum Circulating Pressure

The return velocity in the annulus will establish the rate of circulation, and thus determine the maximum circulating pressure, because all of the pressure losses in the circulating system are functions of mud velocity. For purposes of analysis, the pressure losses in the circulating system can be isolated into three sections of the circulating system inside the drill pipe, the bit water course, and in the annulus between the drill pipe and the hole. In normal drill-

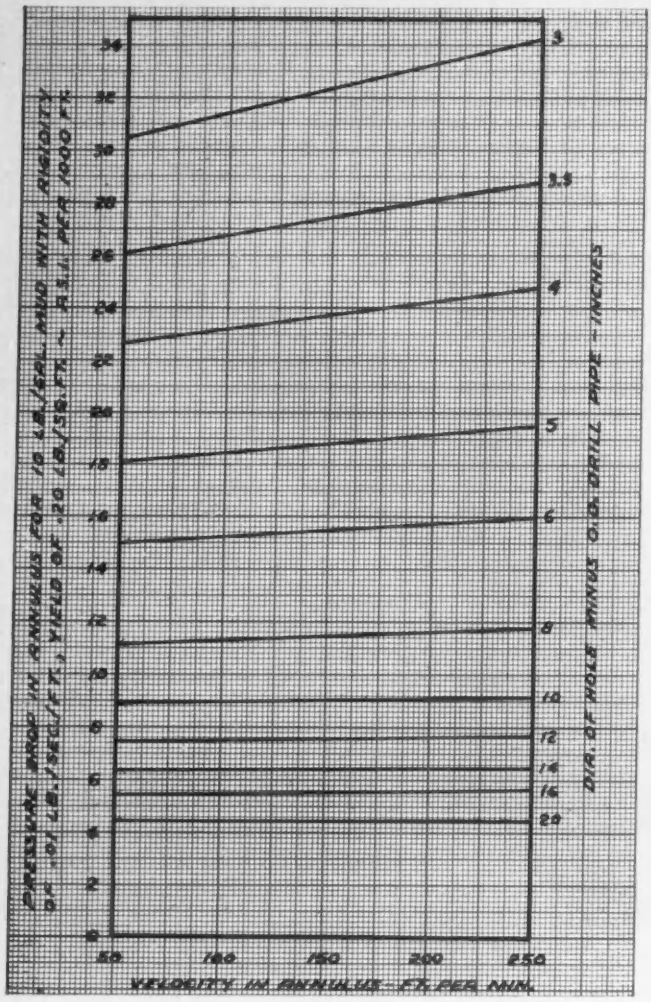
PRESSURE DROP IN ANNULUS FOR 10 LB./GAL. MUD WITH RIGIDITY OF .01 LB./SEC./FT. - YIELD OF 20 LB./100 FT. - P.S.I. PER 1000 FT.
DIA. OF HOLE MINUS O.D. DRILL PIPE - INCHES
VELOCITY IN ANNULUS - FT. PER MIN.

FIGURE 2.

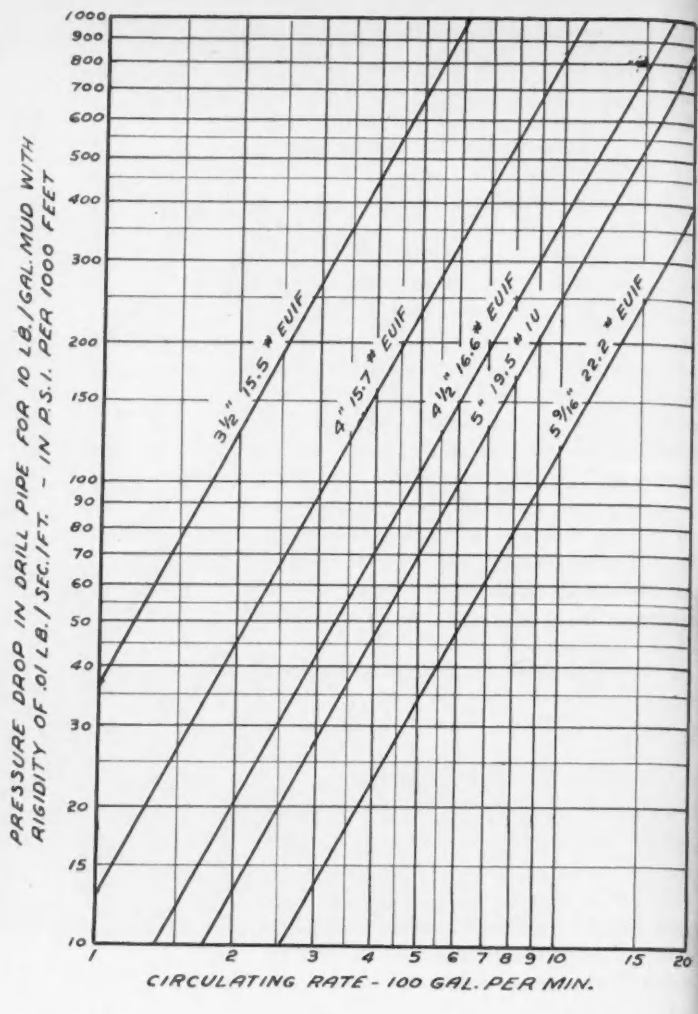
PRESSURE DROP IN DRILL PIPE FOR 10 LB./GAL. MUD WITH RIGIDITY OF .01 LB./SEC./FT. - IN P.S.I. PER 1000 FEET
3½" 15.5 # EUIF
4" 15.7 # EUIF
4½" 16.6 # EUIF
5" 19.5 # IU
5 9/16" 22.2 # EUIF
CIRCULATING RATE - 100 GAL. PER MIN.

FIGURE 4.

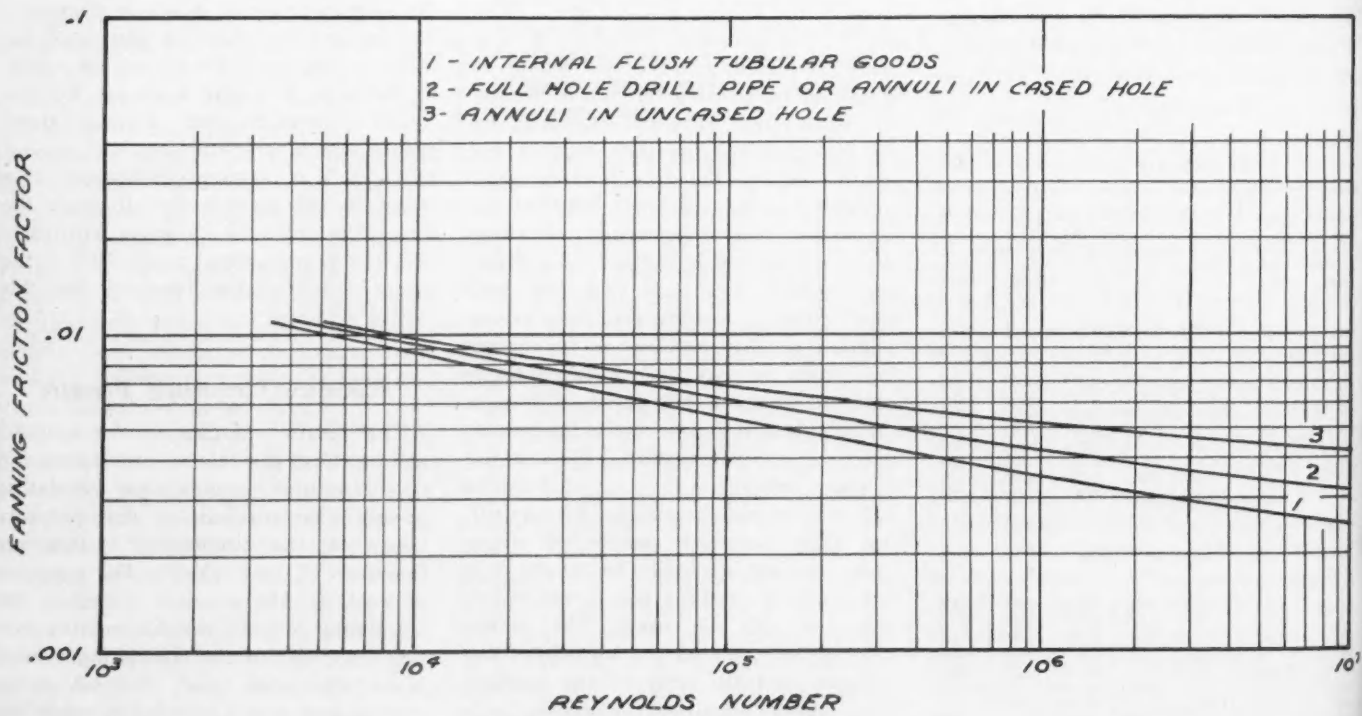
1 - INTERNAL FLUSH TUBULAR GOODS
2 - FULL HOLE DRILL PIPE OR ANNULI IN CASED HOLE
3- ANNULI IN UNCASED HOLE
FANNING FRICTION FACTOR
REYNOLDS NUMBER

FIGURE 3.

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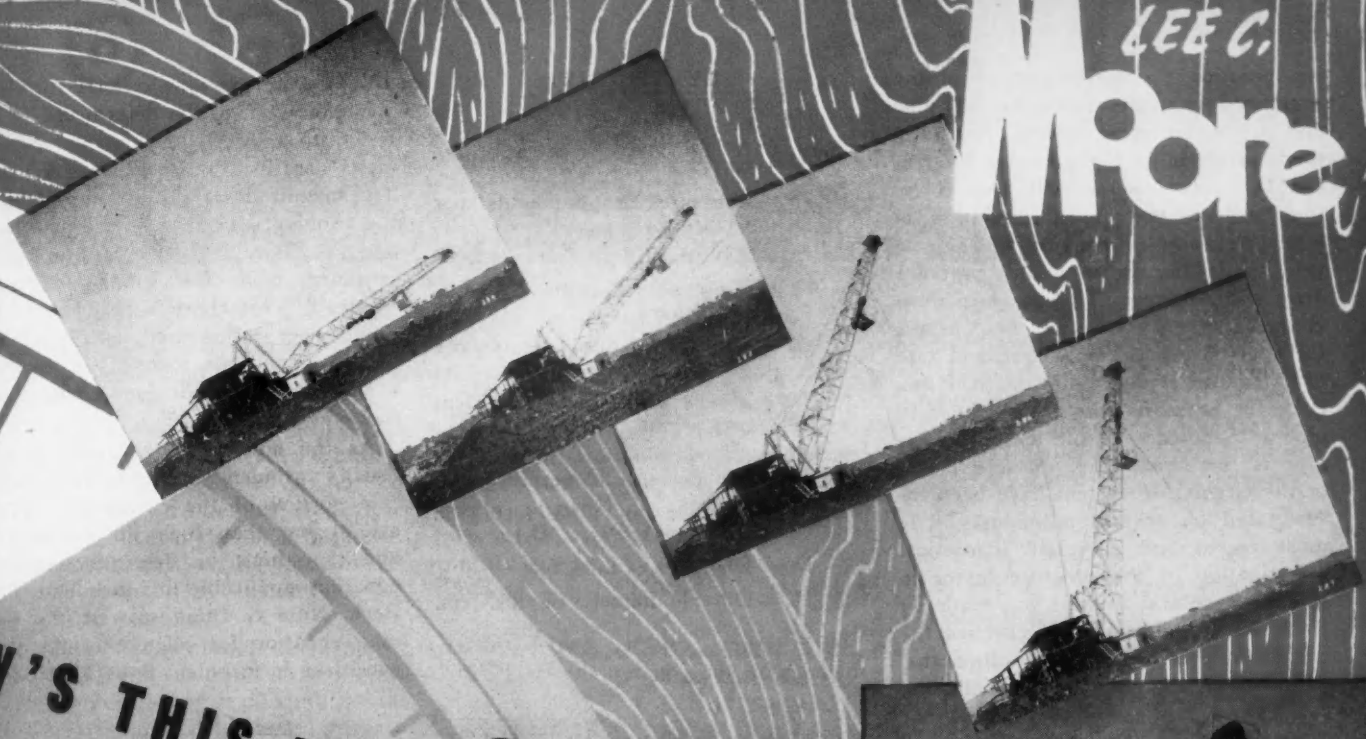

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ing practice, the major portion of the pressure loss occurs inside the drill pipe and in the bit water course. Naturally the magnitude of the pressure drop in the bit water course will depend on their size and the rate of circulation. If bits with water courses for high nozzle velocity drilling are used, this pressure drop will be large. The pressure drop in the bit water course will be constant for a given size water course and rate of circulation regardless of depth. However, the pressure drop inside the drill pipe will increase as the length of the pipe is increased. The pressure losses in the circulating system have been investigated by several individuals. The most recent and complete theoretical investigation of the pressure losses in the drill pipe and annulus was made by Beck, Nuss & Dunn,[4] who checked the calculated pressure loss with the actual pressures observed on several wells and found the results to compare favorably.

Laminar and Turbulent Flows

The pressure losses inside the drill pipe and in the annulus must be considered separately, because the flow in the annulus is usually laminar, and the flow in the drill pipe is usually turbulent. The criterion separating laminar and turbulent flow is the critical velocity at which the flow changes from laminar to turbulent. Beck, Nuss & Dunn recommend the following equation for determining the pressure drop in the annulus when the velocity is below the critical velocity:

$$P = \frac{LY}{27D} + \frac{2NVL}{9GD^2}$$

where:

- P = Pressure drop, pounds per square inch
- L = Length of pipe, feet
- Y = Yield value of mud, pounds per square foot
- N = Rigidity of mud, pounds per second per foot
- V = Means velocity of flow, feet per second
- G = Acceleration of gravity, 32.2 feet per second per second
- D = Diameter of pipe, feet (for annulus $D = D_1 - D_2$)
- D_1 = Diameter of hole, feet
- D_2 = Outside diameter of pipe, feet.

The critical velocity can be determined with the equation:

$$V_c = \frac{1000N + 1000\sqrt{N^2 + \frac{D^2Y\rho G}{3000}}}{\rho D}$$

where:

- V_c = Critical velocity, feet per second
- ρ = Mud density, pounds per cubic foot.

In each of these equations, it will be noted that the mud properties are defined in terms of mud density, yield value, and rigidity. The density is a commonly known property of drilling mud. The yield and rigidity values of a drilling mud are new criteria for drilling muds and can be determined at the well with a special drilling mud viscosimeter described by Beck, Nuss & Dunn. The magnitude of the pressure drop in the annulus with an assumed type mud and various return velocities can be determined from the graph shown in Figure 2. This chart is based on a ten pounds per gallon mud with a rigidity of 0.01 pound per second per foot and a yield value of 0.20 pound per square foot.

As the flow inside the drill pipe is usually turbulent, the pressure losses in this portion of the circulating system are greater than those in the annulus and they must be determined with a equation applicable to turbulent flow. Beck, Nuss & Dunn suggest the Fanning equation for calculating the pressure drop in turbulent flow. That is:

$$P = \frac{FLV^2\rho}{72GD}$$

where:

- P = Pressure drop, pounds per square inch
- F = Fanning friction factor
- L = Length of pipe, feet
- V = Velocity of flow, feet per second
- ρ = Mud density, pounds per cubic foot
- G = Acceleration of gravity, 32.2 feet per second per second
- D = Diameter of pipe, feet

The values of Fanning's friction factor can be determined from Figure 3, and the values of Reynolds number can be determined with the equation:

$$\text{Reynolds No.} = \frac{3.2DV\rho}{N}$$

In this equation for pressure drop, it will be noted that the pressure drop is proportional to the square of the mud velocity, the first power of the mud density, and inversely proportional to the diameter of the pipe. For a given pipe size the pressure drop is directly proportional to the square of the circulating rate. Considering a constant rate of circulation, the pressure drop is inversely proportional to the cube or the inside diameter of the pipe. For this reason, it is desirable to use large drill pipe when large volumes of fluid are to be circulated, because it will reduce the load on the mud pump. The variation in pressure drop with circulating rate for four sizes of drill pipe is shown in Figure 4. This chart is based on a 10 pound per gallon mud with a rigidity of 0.01 pound per second per foot. If the mud weight changes, the pressure drop with the new weight mud will be proportional to the ratio of the density of the new mud to

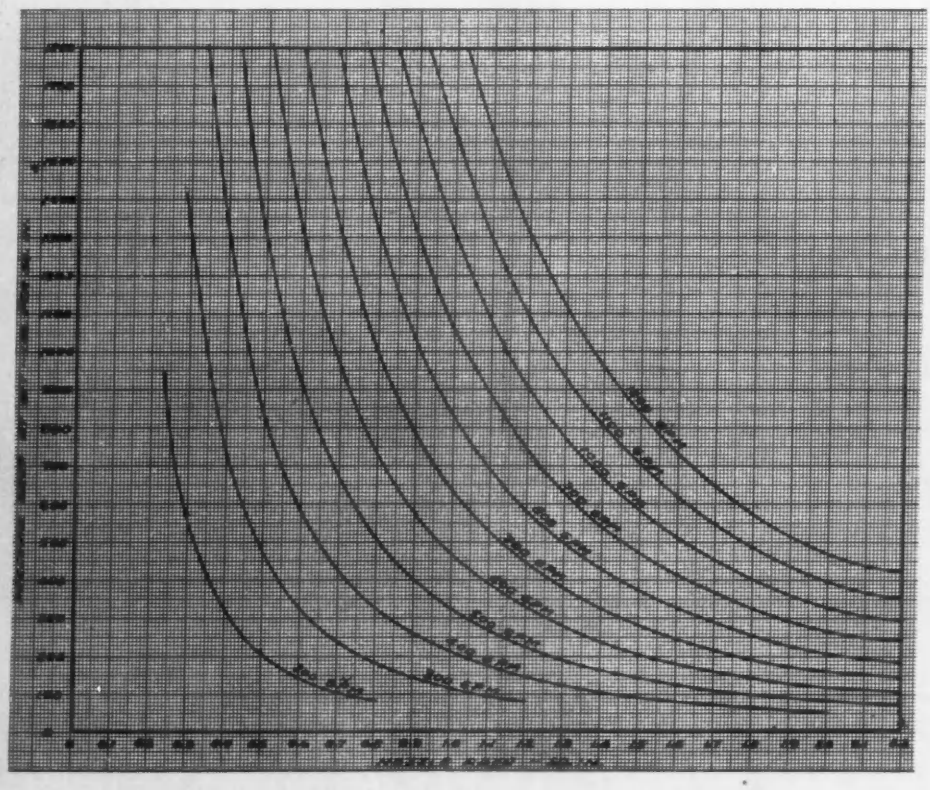

FIGURE 5.

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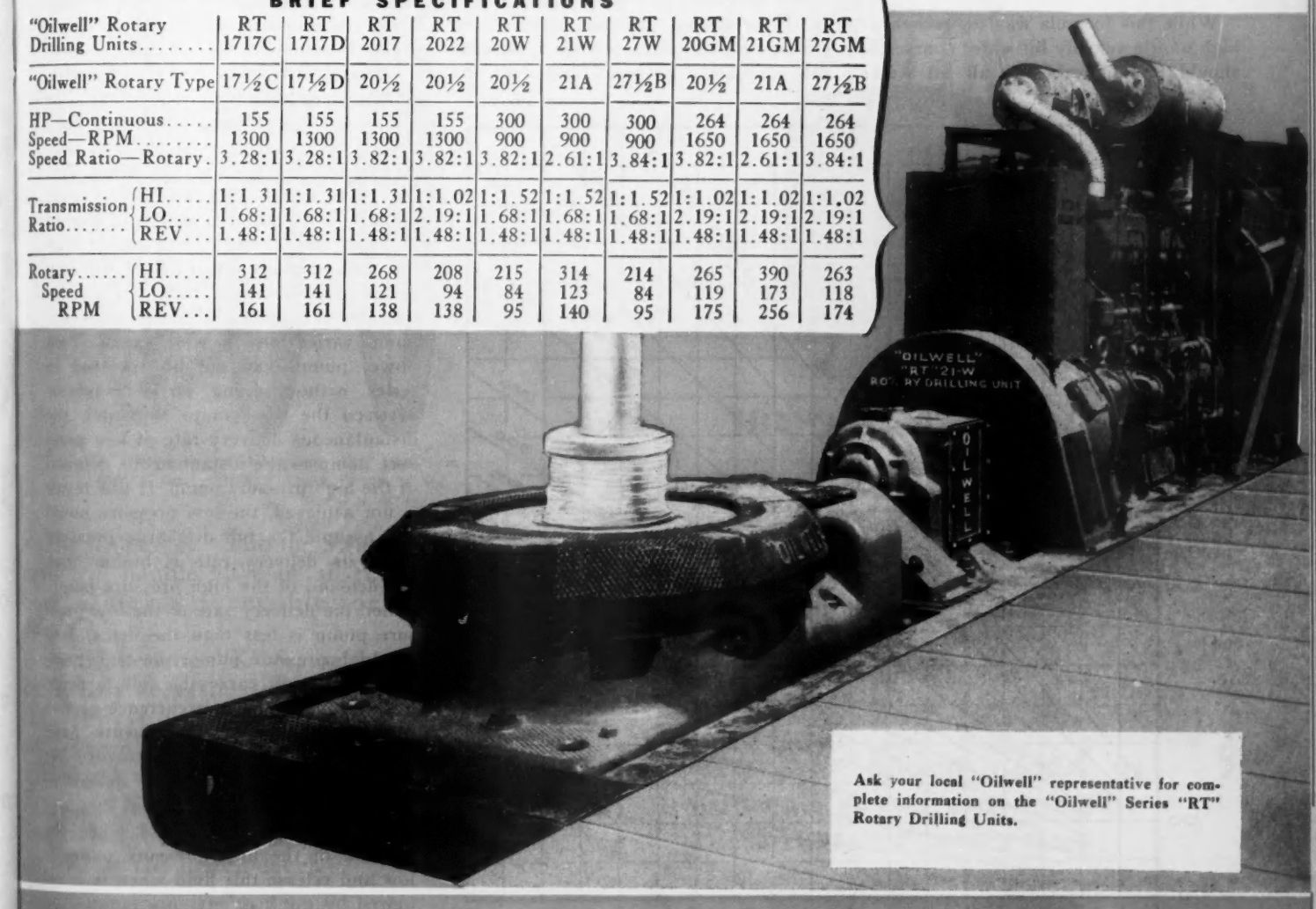
HP—Continuous		155	155	155	155	300	300	300	264	264	264
Speed—RPM		1300	1300	1300	1300	900	900	900	1650	1650	1650
Speed Ratio—Rotary		3.28:1	3.28:1	3.82:1	3.82:1	3.82:1	2.61:1	3.84:1	3.82:1	2.61:1	3.84:1
Transmission Ratio	HI	1:1.31	1:1.31	1:1.31	1:1.02	1:1.52	1:1.52	1:1.52	1:1.02	1:1.02	1:1.02
	LO	1.68:1	1.68:1	1.68:1	2.19:1	1.68:1	1.68:1	1.68:1	2.19:1	2.19:1	2.19:1
	REV	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1
Rotary Speed RPM	HI	312	312	268	208	215	314	214	265	390	263
	LO	141	141	121	94	84	123	84	119	173	118
	REV	161	161	138	138	95	140	95	175	256	174



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the density of the mud used in establishing this chart. For example, if a 15 pound per gallon mud is used the pressure drop will be approximately 1.5 times the value obtained from the chart.

As the mud flow in the bit water course is turbulent, it will obey the same general laws which cover the flow of mud in the drill pipe. That is, the pressure drop will be proportional to the weight of the mud and the square of the velocity, in the water course. In a paper by Nolley, Cannon & Ragland,[1] the following formula was suggested for calculating the pressure drop in the bit water course:

$$P = \frac{Q^2 S}{7606 A^2}$$

where:

P = Pressure drop, pounds per square inch
Q = Circulating rate, gallons per minute
A = Nozzle area, square inches
S = Mud weight, pounds per gallon

Bit Water Courses

While this formula was suggested for high nozzle velocity bit water courses, it should be applicable to all bit water courses. The pressure drops which can be expected with various sizes of water courses and circulating rates are shown graphically in Figure 5.

Examination of the magnitude of the pressure drop occurring in the entire circulating system reveals that the magnitude of the pressure drop in the annulus is extremely small compared to the losses experienced inside the drill pipe and at the bit water course. For this reason, it can be assumed that the total pressure drop in the circulating system will be proportional to the square of the rate of circulation, and the first power of the mud density. As all of these circulating pressure losses represent horsepower, it is desirable to keep them small, because, with the exception of the beneficial effects gained from the velocity at the bit water course, they are a valueless use of power and add to drilling costs. The magnitude of this power loss can be determined from the graph shown in Figure 6, which shows the relationship between pump pressure, circulating rate and pump horsepower.

Two factors are increasing the power loads imposed on slush pumps. The ever increasing drilling depths are creating higher pump pressures, because the circulating pressure losses in the drill pipe and annulus increase directly with drilling depth. The use of high nozzle velocities to increase the rate of penetration in soft formation drilling has added materially to this increasing pump pressure. As neither of these factors reduce the requirements for a reasonable return velocity, the rate of circulation for a given pipe and hole size has not been affected. As the power required for circulating is a function of pressure and rate of circulation they have increased the power requirements place on the slush pump. This has created interest in series operation of power slush pumps, as series operation of steam pumps has been used for several years to solve this problem. The operating characteristics of the direct acting steam pump is admirably suited to series operation, because the low pressure pump will automatically adjust its fluid output to match the fluid requirements of the high pressure pump. This result will be accomplished without creating excessive pressures, as the pressure on the steam cylinder determines the maximum output pressure. In accomplishing this result, the low pressure pump will either slow down or stop when the fluid requirements of the high pressure pump decrease. Unfortunately, the characteristics of the power pump do not meet these requirements as it is a constant speed machine with a fluctuating but constant fluid delivery rate. A characteristic single revolution discharge rate curve for a double acting duplex power pump is shown in Figure 7. From this curve, it is apparent that the instantaneous rate of fluid delivery and consequently the rate of fluid demand at the suction of a duplex power pump varies over a wide range. Two power pumps can not be operated in series without using an accumulator between the two pumps to match the instantaneous delivery rate of low pressure pump to the instantaneous demand of the high pressure pump. If this result is not achieved, the low pressure pump will assume the full discharge pressure when its delivery rate is higher than the demand of the high pressure pump. When the delivery rate of the low pressure pump is less than the demand of the high pressure pump, the high pressure pump will carry the full pressure load. To prevent the occurrence of this condition numerous experiments have been conducted with accumulators between the two pumps. The design of these accumulators is such that they will store up the excessive fluid when the demand of the high pressure pump is low and release this fluid when it is required by the high pressure pump. The volume of this accumulator will depend on its design. If the accumulator is precharged, its total volume can be smaller

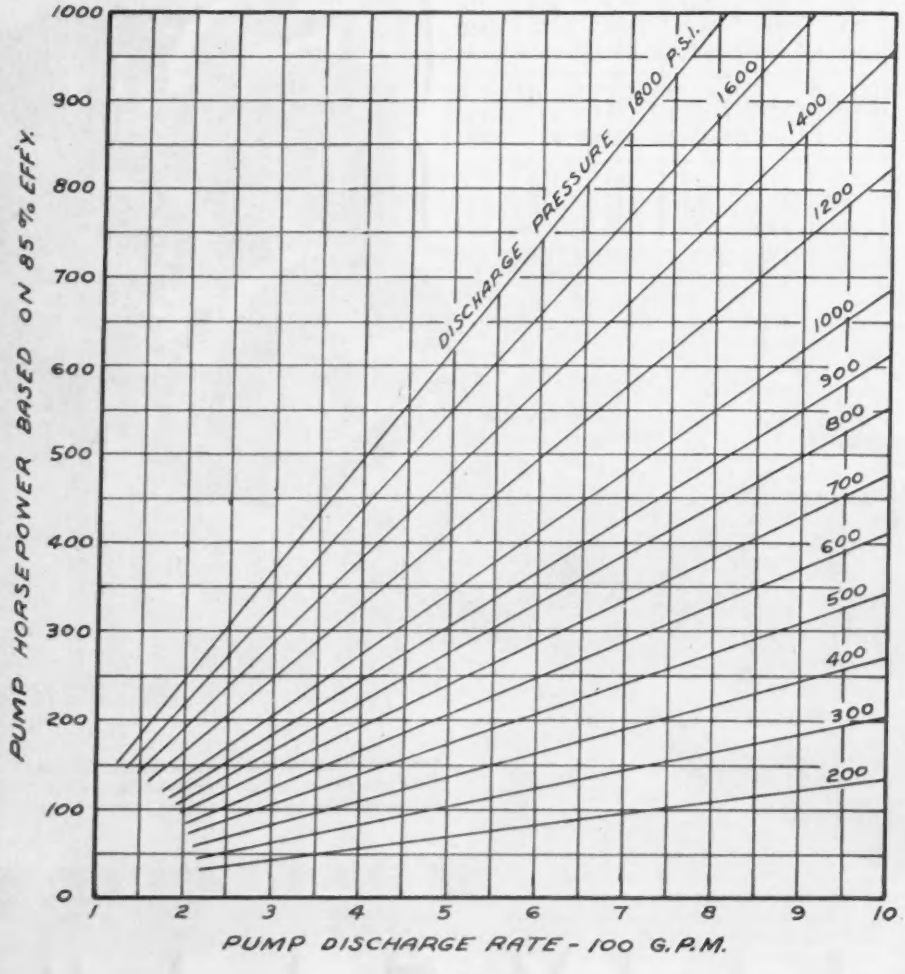

FIGURE 6.

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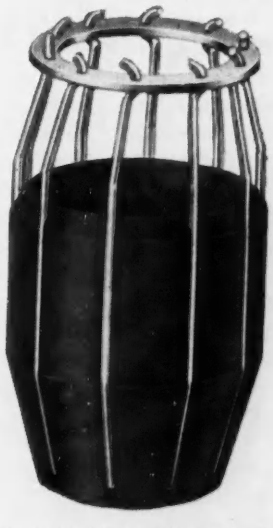

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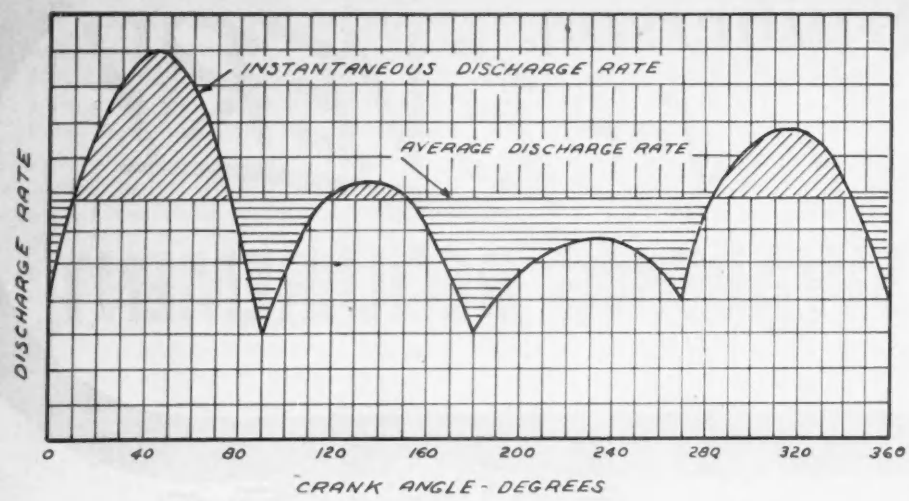


FIGURE 7.

than that which would be required in an atmospheric pressure accumulator, because the effective volume of the atmospheric accumulator will be materially reduced by initial compression of the air. Regardless of the design of the accumulator, the total pressure variation in the discharge of the low pressure pump will decrease as the volume of the accumulator is increased. For maximum pump life, the accumulator volume should be selected to give minimum variations in the discharge pressure of the low pressure pump. The maximum variation in pressure should not exceed 30 percent, if good pump life is to be expected.

As the fluid delivery rate of a power pump is not uniform, it is reasonable to expect the discharge pressure to fluctuate over wide limits, because the pressure losses in the system vary approximately with the square of the fluid velocity. The variation in discharge pressure for a duplex power pump based on the assumption that the discharge pressure varies with the square of the velocity is shown in Figure 8. In this case, it will be noted that the maximum pressure is 540 psi, and the average pressure is 445 psi. In an actual drilling application, this pressure range will be reduced by fluid compression and the fact that the entire pressure loss is not concentrated at the pump but is distributed over the entire length of the drill pipe. However, definite variations will exist in the pressure at the pump, and these variations in loading are imposed on the power end of the pump, the pump drive system and the engine. Part of the energy required to carry the pump through these periods of peak loads is supplied by the flywheel effect of the pump drive, and the remainder is supplied by the engine. If the pump is fitted with an accumulator on the discharge which will reduce the intensity of these pressure variations, the life of the pump and its driving system will be increased, because the magnitude of the peak load imposed on these members will be reduced.

Constant Pressure

As a power pump is essentially a constant pressure machine, that is, the maximum output pressure is constant regardless of operating speed, it is apparent that input power and displacement could be increased, if its speed could be increased. If the discharge pressure were kept constant and the speed were increased, the life of the bearings in the pump would be reduced, but this bearing life reduction could be compensated for by reducing the output pressure slightly. The maximum piston speed in a power pump is established by the pressure drop in the suction system and fluid inertia. If the sum of the suction lift and the total pressure drop in the suction line, the pump suction manifold, through the valve, and the fluid inertia exceeds atmospheric pressure, the pump cylinders will under-fill. If the cylinders under-fill, the pistons will strike the fluid and cause a severe fluid pound. Recently some experimental work has been conducted with higher pump speeds, and the increased pressure loss in the suction system has been compensated for with supercharged suctions. In these experiments, a centrifugal pump which is designed to handle abrasive materials has been placed in the suction line. The pump was selected to produce a pressure of about 25 pounds per square inch in the suction manifold of the pump. A 14-inch stroke power pump equipped with a supercharged suction has been operated successfully at 84 strokes per minute. The operation of the pump at this high speed is quieter than of an unsupercharged pump operating at conventional speeds. Several months experience with this pump indicates that supercharging the suction materially increases the life of the pistons and valves. As the supercharged suction eliminates underfilling of the cylinder and the resultant impacts, it is reasonable to expect this result, because the pistons and valves are not subjected to hydraulic shocks. As these shock loads are also imposed on the power end of the pump, its useful life should be extended when the suction is supercharged.

The increased use of fluid drives in the automotive industry has created

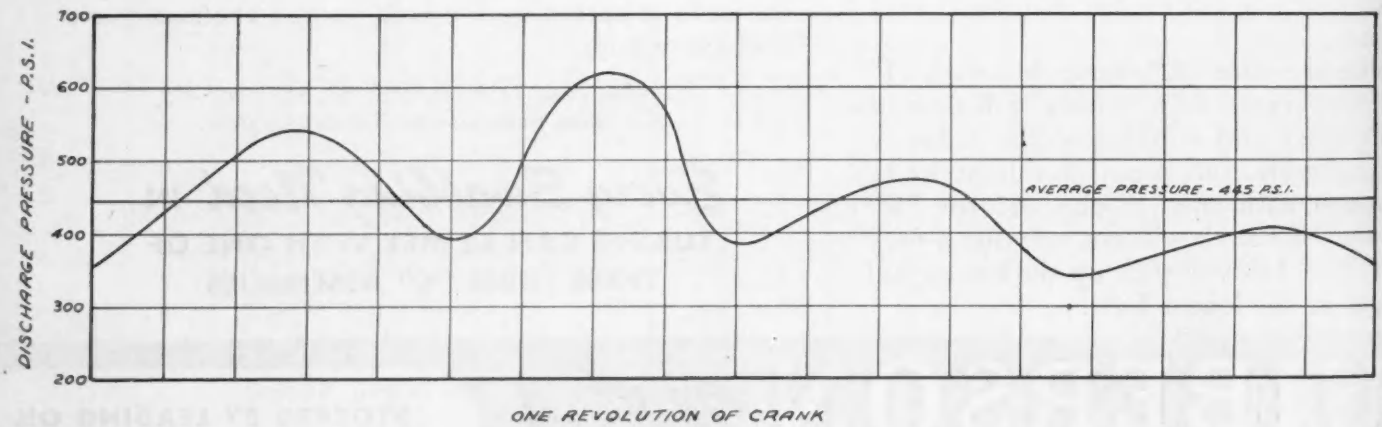
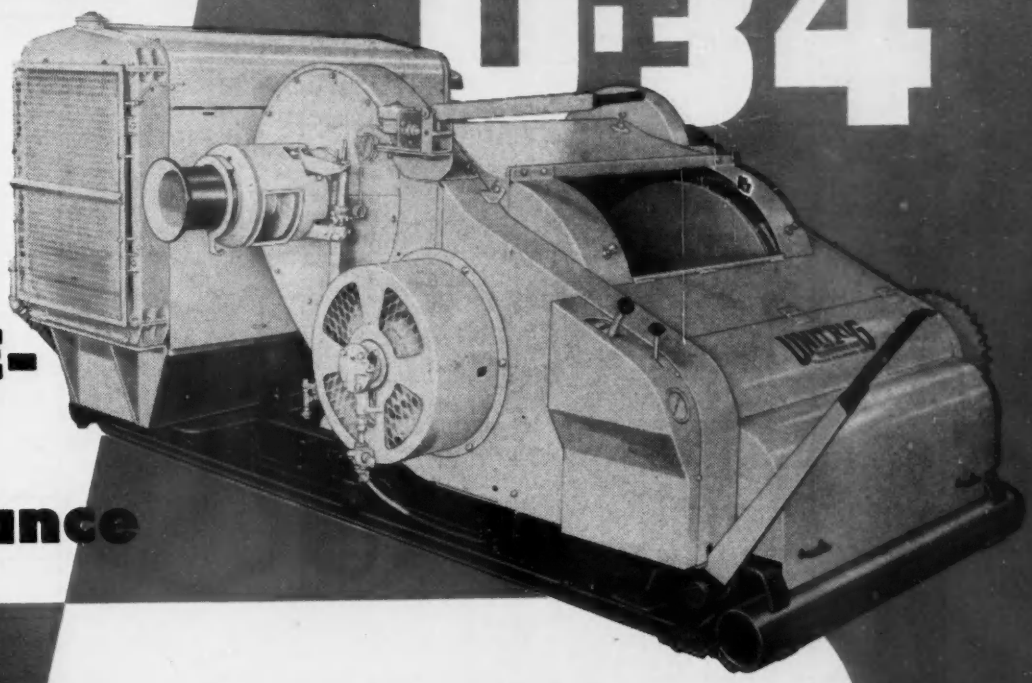


FIGURE 8.

U-34



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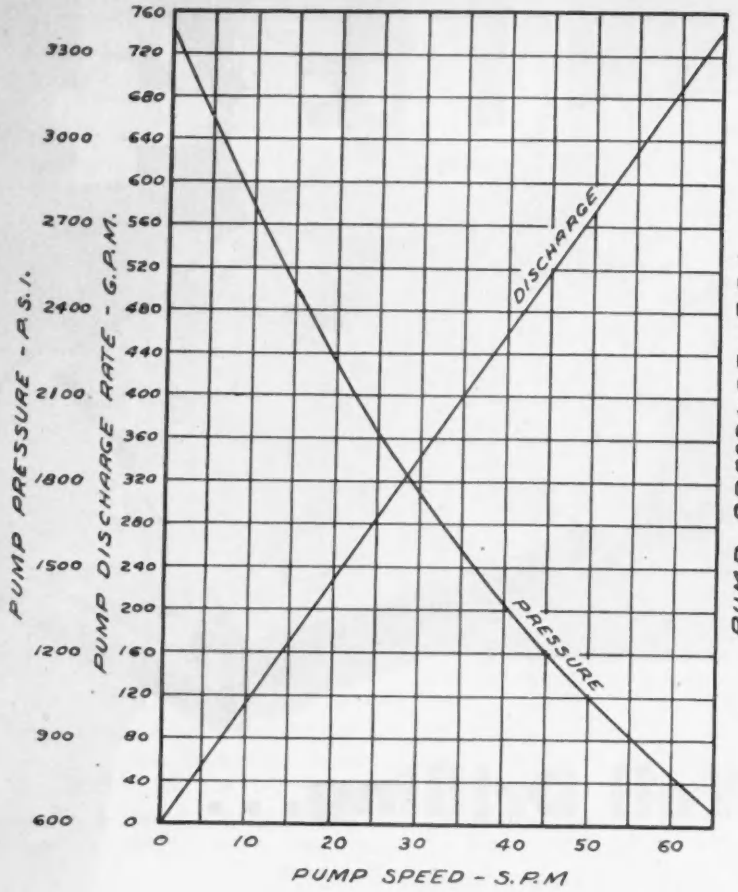

FIGURE 9.

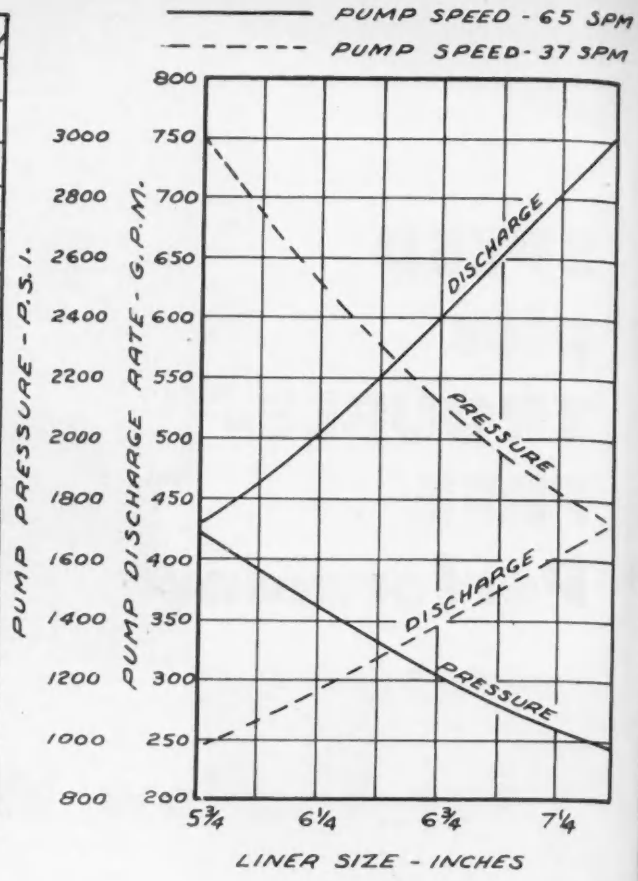

FIGURE 10.

interest in these drives on drilling rigs for both hoisting and driving the mud pump. All types of fluid drives have some characteristics which are desirable in slush pump drives. However, with some of these devices it is possible to dangerously overload the pump. When the pump is driven with a fluid drive, it is possible to stall the pump and hold a constant mud pressure without stalling the engine. This gives the power pump some of the flexibility of the direct acting steam pump. Fluid drives fall into two general classifications, each with its own characteristics. These two classifications are the fluid coupling and the fluid torque converter. The fluid coupling is a constant torque device, that is, the maximum output torque is always equal to the input torque and never exceeds this torque value. When the output shaft of the coupling is stalled the engine speed drops down until the engine reaches its maximum torque point, and this is the torque value which is exerted on the driven machine. This characteristic makes it ideally suited to the slush pump drive, because the slush pump is basically a constant torque machine. The hydraulic coupling will protect the pump from overloads, and it reduces the shock load imposed on the slush pump drive by the pump. Also, it protects the pump and its drive from engine vibrations. It should be a material aid in the series operation of slush pumps, because it will permit the low pressure pump to slow down and speed up to match the fluid requirements of the high pressure pump, providing the inertia of the drive is low.

The characteristics of the torque converter are different from those of the hydraulic coupling as it is a torque multiplier. The amount of this torque multiplication depends on the design of the converter. One design gives a maximum torque when stalled of five times engine torque. Another type has a stall torque of three times engine torque. When a slush pump is driven through a torque converter, it is possible to overload the pump dangerously. If the pump is operated at or near the stall condition at full engine throttle, the discharge pressure will increase to several times the rated pressure, and the pump will be materially overloaded. The exact amount of this pressure multiplication will depend on the drive ratio. The performance characteristics of a torque converter driven 7½ x 16-inch duplex pump with a rated discharge pressure of 970 psi is shown in Figure 1. From this curve, it is apparent that this pump could be dangerously overloaded when driven with a torque converter. However, the performance characteristics are well suited to breaking circulation, casing testing and other operations requiring constant pressure without circulation.

The flexibility of a power pump can be increased by placing a two-speed transmission between the pump and the engine. Again with this arrangement it is possible to overload the pump because the transmission is used to increase the torque imposed on the pump. The performance characteristics of a 7½ x 16-inch pump with a two-speed transmission is shown in Figure 10. The performance characteristics of this pump drive are well suited to breaking circulation. Also, with this type pump drive the pump displacement can be reduced by changing speeds for short time operations requiring reduced volume. However, this type transmission should not be used to save changing liner sizes, if it overloads the pump.

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[2] Nolley, J. P., Cannon, G. E., and Ragland, Douglas. Results Obtained with High Nozzle Fluid Velocity Rotary Bits. AAODC annual meeting, Houston, Oct., 1948.

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By C. E. CLASON

Halliburton Oil Well Cementing Company

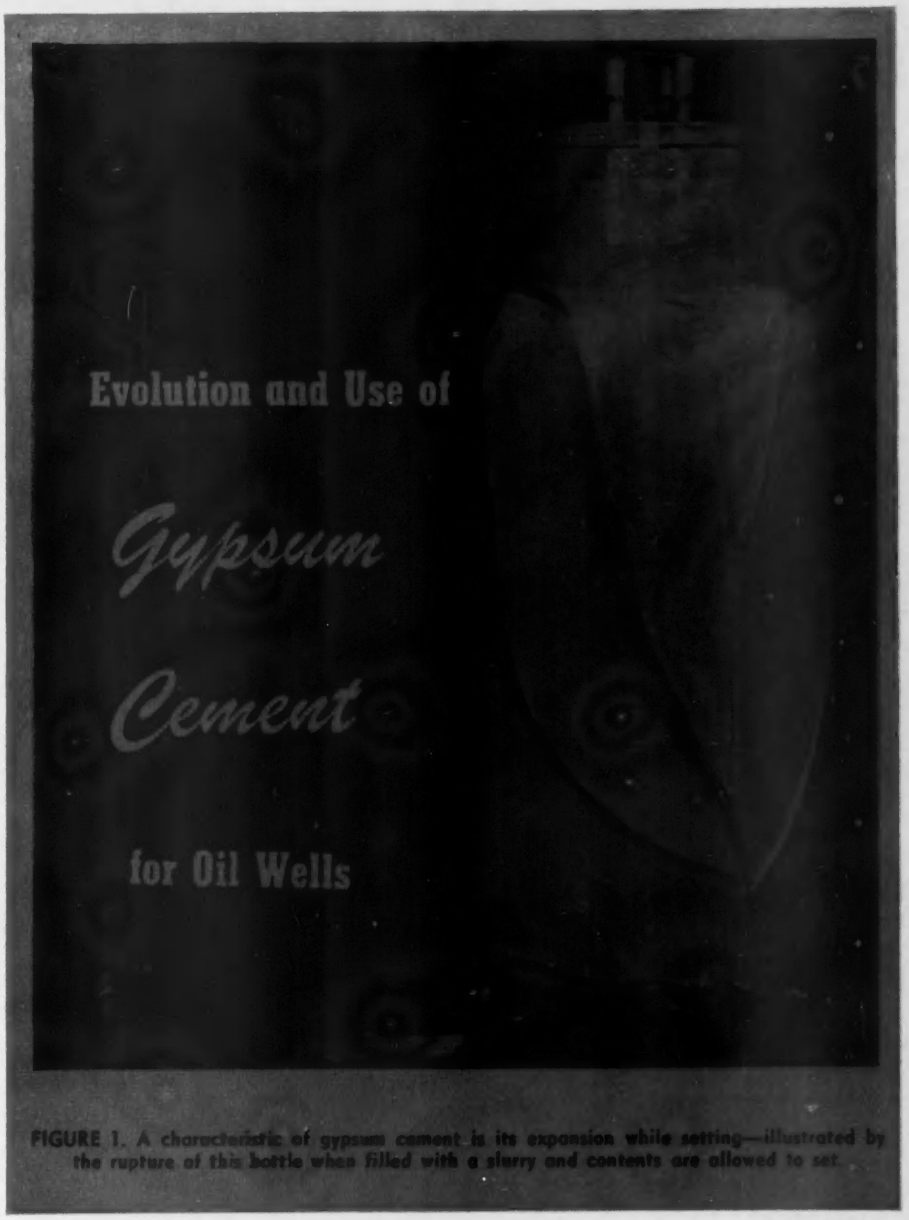

FIGURE 1. A characteristic of gypsum cement is its expansion while setting—illustrated by the rupture of this bottle when filled with a slurry and contents are allowed to set.

GYPSUM CEMENT, compounded and improved to give closely regulated and predetermined setting time, is a valuable tool in oil well completion and remedial work. Although a trade name, and thus legally the property only of the manufacturer using that as a brand name, Cal-Seal has become widely accepted throughout the industry and is the name applied almost universally by the field man. "Gyp," the natural abbreviation, already means anhydrite to the driller, and such a nickname for the gypsum cement would only confuse. The author offers pertinent suggestions in the use of this quick-setting cement, and also indicates possible causes of trouble.

THE utilization of various cements and cementing materials has always begun with those provided by nature. Pitch, bituminous matter and natural portland cements were used long before man had enough knowledge of analysis and synthesis to improve their qualities.

One type that has been mined for centuries is called gypsum and is known by chemists as crystalline hydrated calcium sulfate. It appears to be dry but when heated, water is driven off. But when water is again added and mixed with the powdery material, it will solidify in from five to ten minutes.

The first crude attempt at improvement, later called plaster of Paris, was used by the ancient Egyptians. But there is a vast difference between the present gypsum products and this antique material. Research has provided addition agents and knowledge of grinding and blending so that the modern plant turns out a gypsum cement of far greater strength and durability. A whole new industry has sprung from this and includes the manufacture of wall board and interior structural parts as well as more durable plasters.

It was long realized that this gypsum cement possessed some qualities which made it desirable for oil field use. But for this purpose the slurry must remain in a fluid state until in the desired place in a well. While other improvements were possible by mill and manufacturing manipulation which coincided with oil field use, the setting time was still too short to run the risk of plugging tubing, drill pipe or other equipment.

About 12 years ago, this chemical problem was solved. By adding small amounts of certain compounds, a prolonged but controlled setting time accurate to a small percent was obtained. A new type of cement was ready which could be safely used in the oil field.

The setting time for a slurry was

standardized to take effect in either 30 or 60 minutes. It then hardened quickly and one hour later the compressive strength was 2500 pounds per square inch. This time element abolished a long waiting period as compared to portland cement. It would stiffen and set under gas or air agitation, which made it appear valuable for blowouts or wild wells.

Expansion Upon Setting

Another characteristic, absent in other kinds of cement, was that of a slight expansion upon setting rather than a shrinkage. When placed confined or surrounded by a solid substance, a tighter fit and bond was logical. Temporary bridge plugs, cementing above a nitroglycerin shot to limit the explosive forces to a given area of the hole, indicated a promise of greater efficiency and saving of time over previous methods. It would be more expensive than cement but would be used in relatively small amounts; even large quantities might prove to be cheaper in view of accomplishments.

All of the above expectations have been realized. As usual, with any product, the application has been extended and at the same time been misused. There are certain limitations and conditions that must be observed.

The standard product can be used in wells where the bottom-hole temperature does not go above 140° F. A special mixture can be obtained which extends the use up to 170° F., which means it is applicable in the great majority of wells.

The slurry is subject to change with contamination. This occurs with improper mixing water or foreign bodies such as cement particles, which tend to speed up the setting time to a dangerous degree. However, the weight of the slurry can be varied to suit, as can the setting time. All jobs must be thoroughly planned in advance so as to be completed within the decreed time limit.

Quality of product is maintained by a system of check analyses from the mill up to acceptance for field use. Material that has been in storage is checked before using, and if ever found below specifications, it is discarded. It is packaged in five-ply waterproof bags containing 100 pounds. Each bag will make 1.3 cubic feet of set material when mixed with five gallons of water.

Controlled set gypsum cement is placed in wells either by pumping with regular cementing equipment or with dump bailers. For the dump-bailer process, mixing water is carried to the job. But water that is fit to drink may be used to make the slurry. Waters containing bicarbonate, certain soluble sulfides and organic matter can retard the setting time, while soluble sulfates and salt will have an accelerating effect.

Local waters are always tested by making a slurry in paper cups and noting the time of setting. This is always done for every type of job or job stage. Means are always at hand to either reduce or speed up the setting time, as required.

A light weight dump bailer truck was designed for placing small amounts of gypsum cement at a minimum of expense. The volumetric contents of usual cementing equipment combined with that of tubing or drill pipe made it impractical to handle as little as five or ten sacks. Contamination effect is magnified, either accelerating the setting time or producing an unsatisfactory final product. In cable tool wells and workover jobs, tubing was not always available.

A special dump bailer with full size outlet allows material to drop out the bottom. The mechanical mixer on the truck has a capacity of four sacks, assuring a uniform mix with the correct water content. Conditions may call for a variation of from four to six gallons per sack, depending upon the viscosity desired.

The successful use of small amounts of this product demand that the well be in proper condition. It should always be dead. The walls of the hole should be as clean as possible. The well fluid should have reached its natural or static level beforehand. Under some conditions these demands may be somewhat impossible in degree but to assure satisfactory results they should be complied with.

It is good practice to run the operator's dump bailer or sand pump to check the depth of the hole in order to tie a flag on the sand or drilling line and to find the time required for the bailer to reach bottom. This latter is quite necessary if heavy mud which lowers rate of fall of the bailer is present. To prolong the set of the cement, retarders can then be added to the mechanical mixer. Some of the dump-bailer applications are outlined below:

Tamping Nitroglycerin

SHOT TAMPS: Before tamping nitroglycerin it is imperative that the well be dead and that the fluid be at its natural level. The best results will be obtained with as much open hole as possible left between the top of the gravel bridge and the shoe. This gives the cement more area of the rough formation for bonding and maximum protection of the pipe from shock. After the nitroglycerin has been placed with the umbrella above it, at least six feet of sand or pea gravel should be added. Then several large pieces of broken brick or crushed stone should be dropped on top. This gives a hard surface for the first batch to dump on and prevents the sand or pea gravel from washing up behind the bailer when

FIGURE 2. Cementing equipment may be used for placing gypsum cement, if it first be thoroughly cleaned to prevent contamination from materials previously being handled by unit.

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the slurry flows out. If this occurred, it might stick the bailer. By some operators, the dump bailer is run on a drilling line with a set of jars above for use if needed.

One hour after the previously made surface sample has set, the top of plug in the well is checked and the second batch prepared. This should never be run until the first batch has set. The bailer movement in and out of the soft slurry will thoroughly contaminate it with any oil or mud in the hole, giving a weak and unsatisfactory set. With each batch the bailer should be bottomed and then lifted a couple of feet for at least two or three minutes. It should then be raised slowly until out of the slurry, then brought to the surface as quickly as possible. The bailer is then checked to see that the contents have dumped. If not, the surface sample should be estimated as to time remaining for set before running back to dump again. If the time appears too short, it is much better to release it on the rig floor with loss of good cement rather than risk plugging the bailer and later drilling it out.

Controlled-set gypsum has proven most acceptable in this tamping operation because of the time saved and the expansion feature of the material giving a better bond to the formation and casing. When properly placed above a charge with the well filled there should be no movement of fluid at the surface following the detonation.

Uniform Fluid

A uniform weight and kind of fluid should be used to fill the well. There should be no water for two or three hundred feet with oil from there to the top as the shock wave traveling up beside the casing will always take effect at the oil-water contact and might cause a collapse.

In drilling out the gypsum cement with cable tools, it is good practice to bail the hole after drilling from five to ten feet. Otherwise, the particles may work up around and wedge the bit. If the bailer is run at least every ten feet to remove cuttings, no trouble should be encountered.

No definite rule has been established regarding the amount that should be placed above a shot because of varied formation conditions and amounts of glycerin used. A minimum of a 100-foot plug has been successful.

If the pipe in the cable tool wells was cemented with a small amount around the shoe the gypsum cement plug should extend 25 or 30 feet above the top of this cement. The annular space is often dry, so that the casing may collapse at or just above cement height unless the plug is above this point on the inside.

PLUGBACKS: For cable tool wells and reconditioning old rotary holes, plugbacks have been successful and economical. In plugging back from one pay to another, particularly when the lower is depleted limestone, a very permeable condition may be found. This calls for highly viscous gypsum cement in small and progressively larger volumes. If the first small quantities remain in the hole, a good bottom will be provided for the next attempt and with successive trials, this permeability may be blocked off; then the plug may be built up as desired. If the pulling unit is in good condition, a new dump may be made every hour. This will allow a long plug to be built up during daylight hours.

Non-Permeable Plug

To make a non-permeable plug, the well should be dead so that gas can not disturb the slurry. This will assure a uniform mass of material throughout all parts of the plug. Gas and oil together can mix with the slurry so that it will set in particles rather than in a homogeneous mass.

As time passes, pumping or blowing wells from an upper pay may cause a slight erosion of the plug. It has become common practice to put a couple of sacks of portland cement on the gypsum cement to make a harder cap. Plugs of this type have been in operation for three to four years.

Lower pays have been plugged temporarily with viscous slurry to allow shooting, aluminum pipe removal or otherwise working successively on upper zones. The material, which has not penetrated, can finally be drilled out so that production is obtained again for dual or multiple completions.

BRIDGE PLUGS: For a bridge plug in casing, a cementing top plug may be pushed down below the point to be bridged, using tools or bailer. Ordinarily this plug will give enough resistance to allow dumping. Viscous gypsum cement

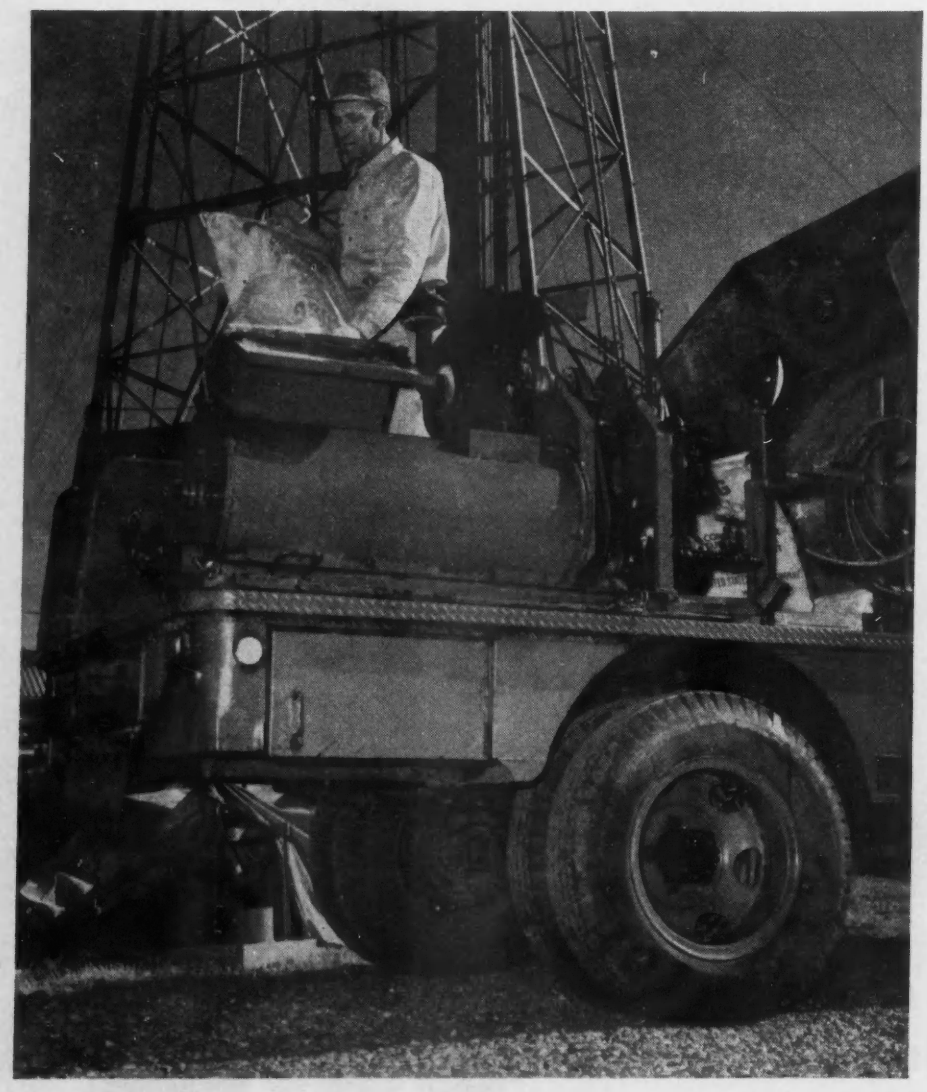

FIGURE 3. A dump bailer truck affords a means for mixing small batches of controlled-set cement with accurate compounding of slurry and maintenance of desired settling characteristics.

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is then placed and allowed to set. The plug may settle a few feet but the bridge may then be built up to the desired point.

If the bridge plug is to be in open hole, an umbrella holding gravel or crushed stone is installed first. The material is then dumped to give the desired height of plug.

Occasionally, before cementing an oil string in cable tool wells a small amount of gas pressure is noticed. It may be enough to prevent the proper set of cement placed behind the casing. If the hole can be bailed dry, enough short setting gypsum may be dumped on bottom to seal off this gas. The cementing operation may then be performed as usual.

There is a type of inexpensive bridge plug called a limit plug which is made to be used with gypsum cement. Because it is limited to use above a low pressure formation, unless the well can be killed, and also to the amount of squeeze pressure from above, a plug is built on it. This reinforcement then allows any amount of pressure to be used for remedial work and the whole can be drilled out afterwards.

In some cases where the formation is not too hard, gypsum cement makes a very satisfactory plug for whipstocking.

Inexpensive mechanical calipers have been devised which enable pre-determination of irregular hole sizes and knowledge of volumes required to fill up any hole to a given point.

Leaking packers which will eventually be drilled out can be repaired by dumping this product. It also has a use in conjunction with cement and resins in shutting off bottom hole water.

Applications of Controlled-Set Gypsum With Cementing Equipment

BOTTOM-HOLE PLUGGING: For best results from bottom-hole plugging, not less than 50 sacks should be used at any one time. This is to allow for possible contamination above and below the material.

First, the cementing sump and tank should be cleaned of mud, cement or bentonite. The pump should be used to wash out all equipment up to the well head. This will prevent a flash set with accompanying trouble.

A few test samples should be made from representative sacks of gypsum cement and the water to be used in mixing. This slurry establishes a preliminary setting time for calculations. If it sets in 60 minutes, deduct 15 minutes, leaving 45 minutes as the limit of pumpability. The material must then be placed, drill pipe pulled free and cleared in 45 minutes, giving this excess time for a factor of safety. Even with this in mind, it is always best to complete operations in less time, if possible, to eliminate the danger of sticking or plugging.

Controlled-set gypsum should be mixed to weigh 15 pounds per gallon or use five gallons of water per sack, so sufficient water should be available in the tank for each batch, for cleaning up and to follow this material. The mixing hopper should be adjusted to a suitable water flow. A 15-pound slurry looks like heavy clabber. Foam appearing on top of the slurry is caused by an excess of water, which should be reduced. A sample should be taken from the sump every ten or 15 sacks. These samples should be placed in a dry place for additional future reference as to setting time.

Being ahead the water used to flush out the sump, pumps and line scours the drill pipe or tubing and also cleans out the bottom of the bore hole. After being mixed, five barrels of water should follow so the final mud will be separated from it.

The pipe should be placed close to bottom and the gypsum cement allowed to equalize inside and out. It is then lifted slowly until about three joints above the theoretical top.

If the joints contain fluid, the drill pipe should not be raised and dropped to jar out the cement. This will mix it up with the mud, reducing strength and hardness. The pipe should be pulled slowly, until out of the slurry; it may then be pulled rapidly. If the joints are still full after pulling, connect up and employ a little pump pressure. Unless the pipe is really plugged, it should clear. Then a couple of extra joints are pulled to be safe.

Returns may be obtained during this procedure. If so, after the pipe is clear, the ram should be closed and when the surface samples begin to stiffen, the plug should be subjected to an easy pressure. If no pressure shows wait four or five minutes for another trial. As soon as pressure begins, the speed should be increased but the top should always be left above the permeable formation.

One hour after the surface samples set, the top of the gypsum cement plug may be checked. If found at the proper place, drilling may be resumed.

If the plug is too low, operations should be repeated. If in running the above job, no returns are established and no fill up is obtained, another procedure is in order.

Enough product is then used to fill up 100 feet of hole, the drill pipe is raised 50 feet off bottom, and the batch is displaced. Due to its weight it will descend and may show a partial loss in the formation with some left in the hole. After setting, the top is found. If the hole should be empty, the material will have traveled outward and set making a barrier for the next batch. It may be found necessary to increase the volume and raise the drill pipe farther up the hole. Another way to locate the plug is to check the fluid level before and after placing the material. If too high, measured amounts of fluid may be pumped into the hole at the proper thickening time, to force the plastic mass into the formation.

The best results have been obtained when the batch is placed just before limit of pumpability occurs.

Often returns may be lost at a shallow depth of from 50 to 500 feet in a water flow. This requires fast action and quick setting. However, there is a risk if done through the smaller diameter drill pipe or tubing. The kelly can be placed in the hole and equal amounts of portland and gypsum cement used. No. 60 mixed with cement, will set in about 15 minutes. By the time it reaches the water sand it should be stiff enough to plug the formation and if the hole fills up, drilling may be resumed.

Caving Conditions

Many caving conditions have been corrected by taking advantage of a predetermined setting time, stiffening action and fast set. As an illustration, in one well a seven-foot cave was at 4000 feet where the casing was cemented. The hole was standing full of water.

No. 60 was used. After a test sample was made to check the set, a cementing plug was inserted in the casing. The gypsum cement was pumped in with another cementing plug following. A measuring line was used and volume calculations made.

Everything dropped about 1500 feet. Pressure was then applied until the bottom of the material was near the top of the cave, and then halted until the samples showed to be quite stiff. Again it was pressured until the last plug went out of the casing at 500 pounds. Fill-up was shown to be three feet. The operation was repeated and three feet more obtained. The third stage gave a pressure buildup of 750 pounds and the plug stopped before leaving the pipe. The cave was filled and this zone was drilled without further loss of returns.

WILD WELLS: Controlled-set gypsum cement is uniquely adapted for overcoming wild wells. The desired setting time can be quickly obtained at the mixer to meet changing conditions. The stiffening action just prior to set raises the viscosity so that it ceases to penetrate the formation. With flash set, no further movement is possible as it is rapidly approaching a compressive strength of approximately 1500 pounds

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per square inch in 30 minutes. An actual occurrence is the best illustration.

In a well near Cement, Okla., a big gas flow was encountered at approximately 6500 feet. The well contained only 200 feet of cemented surface pipe. The bit stuck near the bottom. This was shot off and another bit used, which stuck around 1300 feet. The gas channeled around this bit and out into an exposed dry sand between 800 and 950 feet. It soon started craters in a nearby creek bed and appeared in several old water wells in the vicinity. After a great quantity of mud and cement was used in an attempt to kill this well, gypsum cement was considered.

The first plan was to pump it down through the drill pipe and some two-hour setting material was obtained. Before staging, however, it was found that the drill pipe contained too much cement corrosion. Then 400 sacks were pumped down between the drill pipe and the surface pipe. As the sand formation was only 800 feet down the material was all blown out through this formation so quickly that no results were accomplished.

The next day 500 sacks of No. 60 and a large quantity of accelerator were delivered. This was mixed as viscous as possible and pumped down the annular space between the surface pipe and the drill pipe. As soon as the set had been accelerated to 15 minutes, pressure began to show on the gauge, indicating that the product was setting in the formation. This constant amount of accelerator was carried until the pressure had built up to 750 pounds, or the normal gas pressure. No more accelerator was added to the remainder, as the formation was then sealed. Mud and cement were pumped in behind the sealant and the well closed.

The next morning no gas came out of the flow line and in another day all craters and water wells were dead.

Redwood bark products should never be mixed with gypsum cement, as they prolong the set indefinitely. Scrap cellophane products are inert and may be used if desired, to help obtain a quick stoppage of flow into a highly permeable formation.

Pipe Repairs

SPLIT, PERFORATED OR CORRODED PIPE: Quick-setting gypsum cement has proven an excellent material for repairing split or corroded pipe. A limit plug and gypsum cement are placed directly below the split or hole. After setting, more slurry is then pumped through drill pipe or tubing until the top is above the opening and allowed to stand until the surface sample indicates further movement. Pressure is then applied, forcing the heavy viscous mass outward, allowing the remainder to set in the casing where it may be drilled out an hour after setting of the surface sample. When the split or hole is not too deep, a mixture of gypsum and portland cement may be used provided the mixture is not pumped through small pipe. In five or ten minutes this mixture becomes quite viscous and will be approaching a set by the time it reaches the opening. Perforations may be squeezed off in the same manner.

SQUEEZE JOBS: Gypsum cement has proven a great help in squeeze jobs either with portland cement or alone. In many wells it is customary to attempt a squeeze in low pressure or very permeable formations to shut off water. Large quantities of cement are often required as it is absorbed at a rapid rate by the formation. Even staging cement does not always overcome this condition.

Results are obtained by spotting No. 60 in the bottom and forcing it just outside the bore hole where it is allowed to set. It then forms a barrier against which the regular portland cement squeeze job is then placed. A large number of wells were made water-free by using 50 sacks ahead of 40 or 50 sacks of portland cement, where prior to this procedure, 1000 or 1500 sacks of portland cement alone was used without success.

This same condition often exists in wells with perforations and may be remedied in the same manner. A retrievable cementing tool may be used but when squeezing through this or a similar type, it should always be set high enough so that the casing below will hold the volume of slurry. It is never safe to reverse No. 60 through the tubing or annulus as it may stiffen and set during the time consumed. The following description illustrates the above points.

A well in South Arkansas needed perforations shut off at approximately 5000 feet. For some unknown reason, portland cement had no effect. Approximately 5000 sacks of cement were pumped through the perforations over a period of 30 days without building up appreciable pressure.

No. 60 was finally called for. As two sizes of casing were used in completing the well, the retrievable cementer was set approximately 100 feet above the perforations which allowed space for only 25 sacks. It was used at the highest extreme of viscosity, and required about 25 minutes to mix and spot below the tool. The tool was then released to be sure that none had by-passed above. It was then reset and the material pumped slowly out through the perforations to a final pressure of 3500 pounds. As soon as it had set, the tool was removed and the bit was run to drill out the casing contents. After drilling, the retrievable cementer was run in for a test, which showed the formation took fluid at 3500 pounds. Since 5000 pounds pressure was desired, another stage was indicated. On the second stage only 20 sacks of No. 60 was used and after it was in place, the pump was shut down for about 15 minutes to allow stiffening. Pressure was then applied and by the time six or eight sacks had gone into the formation, it had built up to 5000 pounds. Pressure was held until set and after drilling out, the formation held against 5000 pounds pressure. Both stages, drilling out and testing, required only about 36 hours.

Initial Resistance

Some formations showing an initial resistance to taking fluid under pressure, will break down so that too much permeability exists to build up a squeeze pressure. This creates a similar condition to the above and becomes the same problem.

When gypsum cement is dehydrated against a formation and sets under high pressure, the resulting plug is extremely hard and will have a correspondingly higher compressive strength.

CEMENTING SURFACE PIPE WITH GYPSUM CEMENT: Controlled-set gypsum cement is often used in fast drilling campaigns to cement surface pipe. The usual practice is to combine it with portland cement slurries. For example, if a total of 75 sacks is figured to cement the surface pipe, 50 sacks of portland cement will first be pumped followed by a plug and then 25 sacks of gypsum cement and another plug so that the measuring line may be used. The entire volume of cementing slurry is then forced down and outside the pipe until some is left in the bottom and up past two or three joints. With No. 60, drilling may be commenced again in three or four hours. This product around the bottom joints will hold the casing in place as the portland cement above it sets, saving a great deal of waiting time. As usual with all surface pipe jobs, it is best to set the shoe in a hard formation to insure a tight bond.

Gypsum cement has been found useful in core drilling operations, which also experience lost circulation and caving. At the present time, work is being done which shows possibilities for better results in seismograph operations.

The foregoing description of the product and its benefits have not covered all uses to which this material is adapted, but may serve to show the possibilities for future problems.

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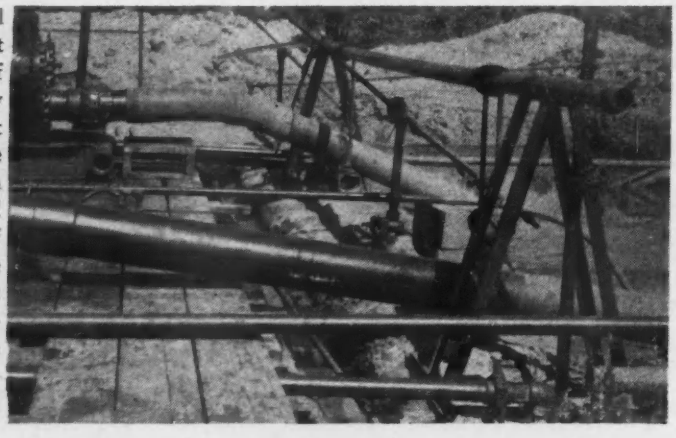
HOW TO—Support and Adjust Mud Suction Lines

The desirability of taking drilling fluid from the slush pit at some point well off bottom but below the surface makes it necessary to provide some type of suction support for the mud pumps. The use of flexible hose in the mud suction line has facilitated the problem of adjusting the height of the intake.



In the installation shown, two parallel mud pumps offset each other, one being nearer the power compound of the power rig drive than the pump shown in the background. This displacement made it necessary to provide a longer pump suction, and complicated somewhat the adjustment problem. Two A-frame members and a horizontal cross bar supplied the answer.

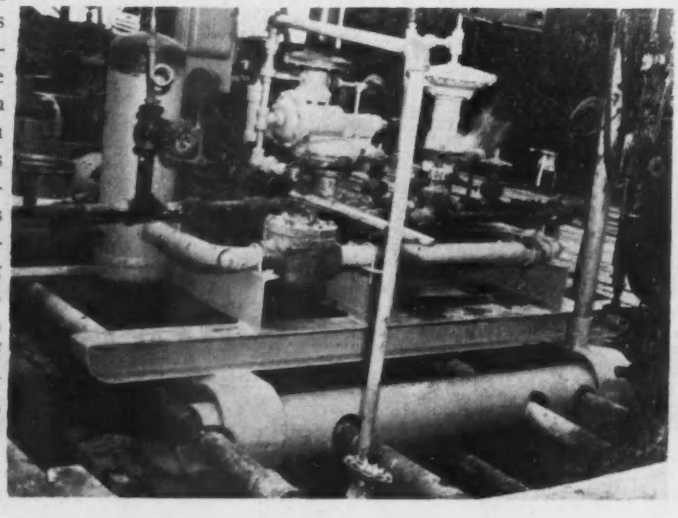
The frame sections were constructed of angle iron, terminating at the apex with a saddle made from a half-section of pipe. These frames are equipped with footings to offer a foundation in soft soil. The cross member is a worn joint of 4½-inch drill pipe which is used "as is."

That part of the suction line placed in the mud pit is of eight-inch pipe equipped with a strainer at the end. Eyes have been welded to the casing section so it could be supported by manila rope. In the case shown, the metal section of the suction in the foreground is considerably longer than that of the second pump, due to their respective locations. However, the adjustment of either is made in the same manner. The rope is tied to the eye on the metal section, then wrapped around the horizontal pipe four or five times and the bitter end anchored with a weight. This weight on the loose end aids the rope in holding to the drill pipe similar to the action of the cathead and catline.

A 36-inch pipe wrench is used to raise or lower the suction lines of both pumps simultaneously. Differences can be adjusted by slackening the wrappings around the drill pipe to lower further one of the suction lines.

HOW TO—Set Up Automatic Boiler Firing Unit

The automatic boiler firing unit is the heart of the control system on the steam generation plant of any steam drilling rig. For this reason, a wide variety of types and sizes of pipes are connected to it. Making up the unit at a location is sometimes difficult because of the problem of how to lead the lines up to the control unit.



One simplified hookup, as illustrated, makes it unnecessary to support the firing control skid on blocks in order that the piping can be connected to the controls from underneath. Instead, where desirable, the lines are brought through the large pipe cross piece on the main skid body. The intricate firing control mechanism is mounted on a smaller skid which is cross mounted on the larger and heavier skid frame that also carries the steam turbine generator.

This unit can be placed directly upon the ground or upon a boarded area, and the piping connected to it through the holes which have been cut through the cross braces as shown. These supporting members are weakened somewhat, but they are still sufficiently strong to carry the relatively small load imposed by the equipment they support.

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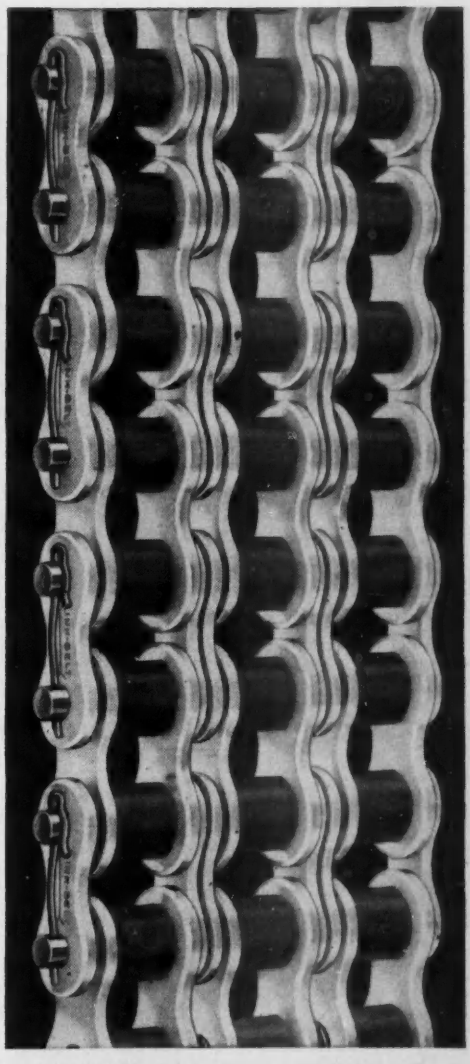


It's a long way down to the "business end" of holes these days . . . often between three and four miles. That makes a round trip of close to six to eight miles. With drill pipe loads approaching 200 tons, the call is for better and more powerful drives. Link-Belt Precision Steel Roller Chain is the answer.

So well has this strong, flexible, precision finished all-steel chain performed—under the toughest drilling conditions throughout the world —it's popularity has leaped ahead among the men who build, the men who buy, and the men who operate drilling rigs.

Link-Belt Precision Steel Roller Chain is built to manufacturers' (A.S.A.) specifications in standard sizes, in single and multiple widths. Meeting all drilling requirements, Link-Belt chain is available at your supply store.

> E-Z-ASSEMBLY <

Link-Belt engineers have developed a construction that makes assembly and disassembly of multiple-width chains in the field *much easier*. With this feature, load distribution across the width of the chain is maintained.

LINK-BELT COMPANY

Indianapolis 6, Dallas 1, Houston 3, Los Angeles 33, Kansas City 6, Mo., New York 7, Toronto 8.
Distributors in all fields. 11,571

LINK BELT
Precision Steel
ROLLER CHAIN

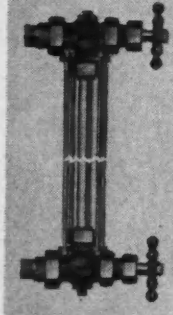
PENBERTHY
Liquid Level GAGES

REFLEX

Reflex type complete with gage valves. Liquid shows black—empty space shows white. Liquid level is always unmistakable.

TRANSPARENT

Transparent type complete with gage valves. Used where through vision is desired under high pressures and/or temperatures.

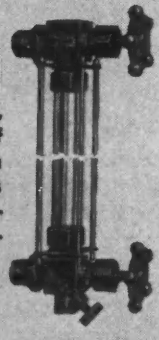


DROP FORGED STEEL

Tubular glass type, Chrome-Moly temperature resisting steel body, stainless steel trim, regrinding removable seats.

ALL IRON

Tubular glass type, extra heavy body of special high strength alloy iron, shanks alloy steel, trim stainless steel, valves self-cleaning.



There is a Penberthy Gage of superior quality for every liquid level gage requirement. Gages are fabricated to customer's specifications from special alloys to meet unusual corrosive and temperature conditions. All Penberthy Gages conform with API-ASME requirements.

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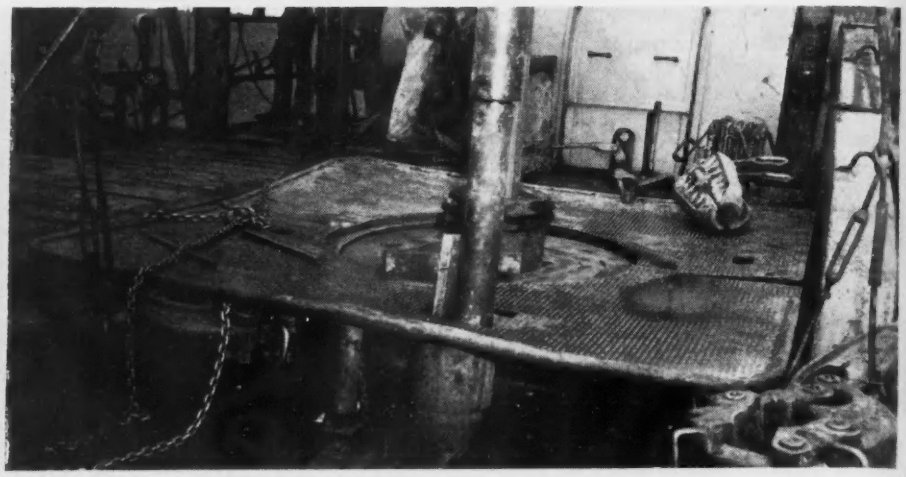
PENBERTHY PRODUCTS

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant—Windsor, Ontario

HOW TO—Build Elevated Platform



Arguments for and against rotary tables protruding above the derrick floor account for the variation in floor and rotary arrangements. It is generally agreed, however, that a floor flush with the top of the rotary table is less hazardous to personnel. But rotary settings which provide for a completely unobstructed floor are expensive since they require a special sub-structure design to accommodate the rotary below normal floor level.

The platform illustrated is a compromise between the two possible conditions whereby the area around the rotary is flush with it, but no special sub-structure construction was necessary to effect this arrangement. An area of about 50 square feet surrounding the rotary was covered with a platform to eliminate any stumbling hazard as well as to protect the rotary from being struck by heavy equipment.

The platform was made of two pieces of one-fourth-inch floor plate steel measuring about seven feet on all sides. It was split in the middle and a circular opening was cut about two inches larger in diameter than the rotary table opening. Corners were rounded and split one inch pipe welded to cover the edges for additional protection from cutting crew personnel. Holes were cut in one section to accommodate the rathole opening as well as to provide lifting holes.

Unique in the platform is the method of support on the half extending away from the rotary where the floor is about one foot lower. Three jack screws were improvised, one in each corner and one in the center, so that they can be adjusted to variations in height from one location to another. These screws are internally-threaded sections of pipe into which are screwed matching bolts that have as their heads a square foot plate of steel.

HOW TO—Add Splashboard to Floor

The driller on one rig used this simple idea to protect his shoes from getting wet and muddy when coming out of the hole with the drill pipe. It is a splash-guard made of a piece of sheet metal from the scrap box. The metal was wedged between the drawworks skid and the derrick floor, rising above the floor about eight inches. Mud splashing from the drill pipe and running on the floor would be deflected from his position, thereby keeping his footing area dry as well as preventing his shoes from getting wet and muddy.

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Forced Draft
FIRING
SYSTEMS
SAVE

FUEL by improved combustion resulting from perfect mixing; by retaining heat inside firebox for maximum energy; by maintaining uniform firebox temperatures to prevent fluctuations.

WATER because stack blowers and steam jets are eliminated; by producing hotter, dryer steam for increased usable energy from each boiler.

REPAIRS by preventing cold drafts in firebox, thus eliminating the major cause of flue warping and fatigue failure; by sharply reducing flue scaling.

On off-shore work, where steam has already proved to be the safest power, reductions in requirements for fuel, water and repairs represent tremendous savings.

It is in such work that Owen Forced Draft Firing Systems earned their reputation . . . a reputation for economy, safety and efficiency unequalled by any other oil field boiler firing method.

Owen Firing Systems function perfectly with gas or oil. With high-efficiency forced draft burners, greatly improved duck's nests, a force-feed fuel system (when firing with oil) and closed, pressure-tight doors, they eliminate the waste, damage and fluctuations caused by out-moded firing methods. Perfect control of fuel, water and steam pressure is provided through a completely equipped Owen Instrument Panel which permits accurate, remote control of each and every boiler.

For highest efficiency and greatest economy, do like so many off-shore operators have already done . . . equip your boilers with Owen Forced Draft Firing Systems.

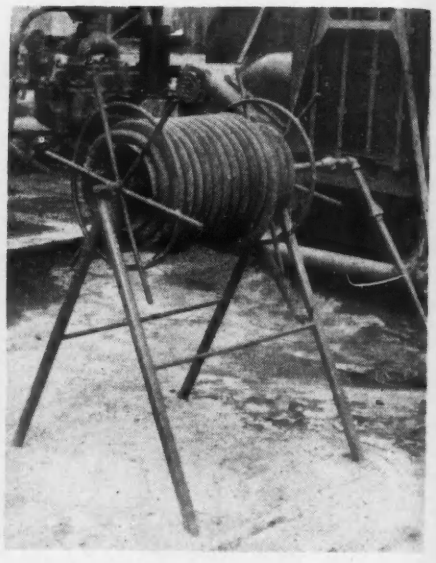
FOR COMPLETE INFORMATION, write for the Owen Catalog . . . see Pages 3299-3309 in your Composite Catalog . . . or, still better, let us fly you in the Owen plane to an off-shore location where you can see an Owen Firing System in operation. We'll pick you up at your convenience.

OWEN

OWEN TOOL COMPANY
4718 West 18th Street Telephone VA-4341
HOUSTON 7, TEXAS

HOW TO—Build Low-Cost Portable Rack for Fire Hose

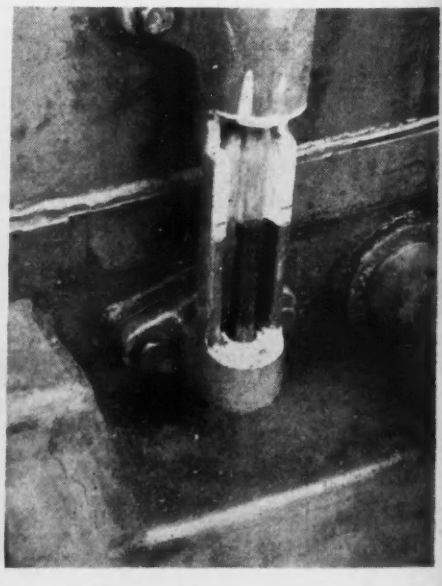
An important fire prevention measure taken by the drilling department of a major company consists of setting up at each location, within or near the equipment area, a small fire hose reel which at all times remains connected to the manifold of a nearby pump. The reel, designed to handle from 150 to 200 feet of high pressure rubber hose, is wrapped around a drum which may be hand-rotated by means of spoke wheels at either end. The pipe axle, which is also the supply line, is connected by means of a straight-run high pressure swivel joint to the permanent line which goes underground to the pump. Mounted on a simple A-frame base, the unit is easily picked up and moved from one location to another, and provides a positive, inexpensive means of preventing the occurrence or spread of fires within the rig area.



Rod line weights
for every purpose
Machined from Solid Steel Bars. Can be furnished in any weight or length desired.
Sensitive ball bearing in both ends insures free swiveling.
Quick opening safety bail on both ends.
Capacities from 15 to 50 Tons.
WRITE FOR CATALOG
McKISSICK
McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

HOW TO—Indicate Oil Level

Operators of engines which are fitted with oil level indicators of the gauge glass type are more likely to notice the oil level if a distinguishing color com-



bination is used. On these glass gauges, the normal level is indicated by a narrow black line on each side of the glass. It is striped on after the entire fitting is painted a reflecting white behind the glass as well as on the sides of the glass holder. This normally would show at a glance whether the oil level in the crank case is sufficient for operation.

So that a warning will stand out to show the operator the quantity of lubricating oil in the engine when the level falls below the operating gauge line, the lower part of the fitting is painted a fire engine red. The red begins at a point below the normal black line which indicates the point at which a quantity should be added. The space below the black line, between it and the red, is white for approximately one-half inch. When the operator passes on his tour of inspection, the level of the oil is shown distinctively whether it is at the black line, or starting into the red danger zone.

HOW TO—

Rack Long Tools

A convenient, inexpensive method of racking and storing spanners, crowbars and various long-handled tools used within the mud pump area is contained in the installation shown. Short sections of salvaged two-inch pipe or pipe nipples, when welded at several points around the vertical posts supporting the shelter over the pumps, provide ideal and readily accessible means of storing tools. Key to the success of this type of rack is the circular plate which is welded to the post and which serves as a base for the tools.

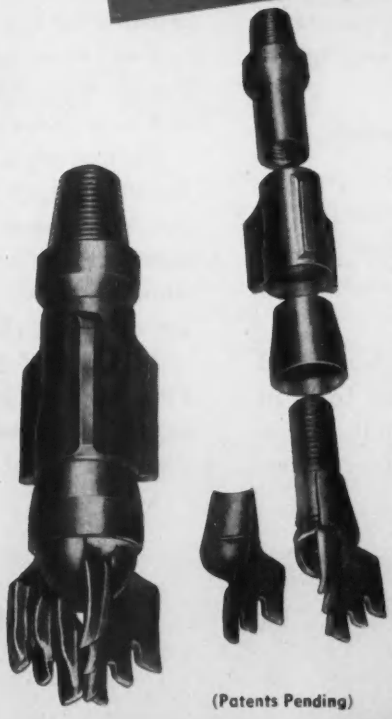
Made of one-fourth-inch steel plate, the base member does not interfere with the normal movement of workmen and does not hinder the normal assembling or dissassembling of the structure. Valuable time is saved when a tool is needed in a hurry and there is less likelihood of such tools becoming misplaced or lost, the handy rack tending to encourage the replacement of tools after they have been used. By painting each post and the tools regularly racked at that point a particular color or shade of paint, such replacement of tools would be easier and more certain.

EXPLORATION DRILLERS:

HAWTHORNE Replaceable Blade "ROCK CUTTER" BITS

cut bit and footage costs... drill faster!

On four Continents, in every potential oil-bearing area, Hawthorne Replaceable Blade "Rock Cutter" Bits are speeding the work of exploration parties.



(Patents Pending)

It's well known that the cost of seismographic work is largely dependent upon the speed of drilling shot holes. That's why more and more exploration drillers are using "Rock Cutters" in 95% of their operations.

Discover for yourself the economy — the greater convenience — the vastly superior drilling efficiency you get with Hawthorne "Rock Cutter" Bits.

See GEOPHYSICAL DIRECTORY or COMPOSITE CATALOG for lists, parts, prices—or write for illustrated Catalog.

HERB J. HAWTHORNE INC.

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COIL IT

HANDLE IT ROUGH

GOODALL

FLEXO

LONG LIFE Rotary Hose

is built to take it

Your rewards for specifying Goodall Flexo Rotary Hose are longer hose life, greater ease of handling and lower hose costs.

That is because Goodall Long Life Flexo Rotary Hose is made on a completely different construction principle that does not depend on tightly wrapped wires for strength.

That construction principle puts Goodall in a class by itself.

It is the only hose that is strong enough to withstand normal whipping from mud pump surge, and at the same time is flexible enough to be shipped in 63″ crates.

Ease of handling is another "plus" benefit of Goodall Flexo hose. It is so flexible and light in weight that all you have to do is loop it into a manageable sized coil and transport it . . . the only precaution necessary is to protect from being crushed or cut by heavy equipment.

You save money too because Goodall Flexo Hose, with Barney Coupling, greatly outlasts ordinary rotary hose.

Unique also, is the complete repair department maintained by the Goodall Rubber Company, for the convenience of Goodall Rotary Hose customers. This service, plus the many advantages of Goodall Flexo Rotary Hose, makes Goodall the favorite of drillers all over the world.

Because of these outstanding features, Goodall Flexo Rotary Hose has long been the favorite of drilling contractors and leading oil companies all over the world.

To get even longer service from your Goodall Rotary Hose, use a swing joint between the standpipe and hose. The extra long service you get from the swing joint installation will reduce hose costs almost to the vanishing point.

GOODALL RUBBER COMPANY — TRENTON, N. J

GOODALL RUBBER COMPANY OF TEXAS: Houston, Texas
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EXPORT: Goodall Rubber Company, Trenton, N. J.
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HOW TO— Make Mobile Butane Unit

Butane is becoming a popular fuel for drilling rigs operating in wildcat areas where trucking gasoline or diesel fuel would be more expensive. One major problem confronting operators of butane-fueled rigs is that of sufficient supply to last over relatively long periods.

When the going is rough and fuel requirements are high, both time and material can be conserved by constructing a butane trailer unit for fuel storage. Ordinarily, the drilling contractor sets one or two spheres near the rig, and butane is transferred from a truck tank into these spheres or cylindrical tanks for usual consumption of fuel. But when the power loads are heavy and continuous, a sphere is soon drained and another load is required.

An ample supply that will last for long periods can be provided by a trailer unit such as that illustrated. A low-boy trailer frame was equipped with four large interconnected pressure spherical vessels. They are individually mounted on box type foundations welded to the trailer frame. Copper tubing to carry the liquefied petroleum gas from the spheres to the fuel system of the rig is connected to the usual fittings on the tanks and manifolded into the fuel line to the regulators and vaporizers.

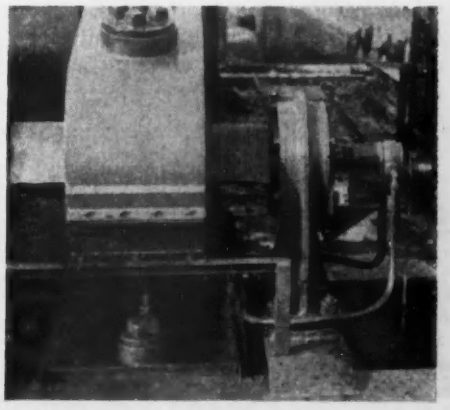
A system of trailers makes it a simple matter for a few truck-tractors to keep a continual supply of butane on many rigs. When a rig is moved, a truck can pick up the empty trailer and exchange it with one that is filled. No time is wasted in loading and unloading the fuel containers.

HOW TO— Add Lubricant Reservoir

Instead of using the chain case as a sump to contain the lubricating oil, replenished for operating level by more or less frequent filling through the top half, the chain can dip into a constant level of oil by using a pump to circulate the lubricant from an outside reservoir. The oil reservoir is a rectangular box, built to fit between the skid-type foundation members of the unit and supported by angle iron pieces welded to both top edges with extensions for the support and so the reservoir can be removed for an occasional washing to remove sediment.

A gear pump is mounted on a bracket attached to the outboard bearing and connected to the end of the drive shaft. The oil suction line leads from the pump intake to the reservoir at any desired point above the bottom where a wire mesh strainer is attached to the suction end of the copper line.

The pump discharge leads to the chain case at or above the desired oil level opposite the overflow line which carries excess oil back into the reservoir below the chain case. The outlet position of the overflow line is fixed at a point where the desired level of oil is to be maintained to provide adequate submergence of the chain at this point for constant lubrication.



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It removes scale and corrosion safely; guaranteed harmless to personnel and equipment.

Being pure tropical resins, all active ingredients; its colloidal action is so gentle and so positive. No carrying agents.

The resultant clean heat transfer surfaces bring about definite reduction in fuel consumption.

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definitely increases. You enjoy more power and more economy and longer equipment life.

Sand-Banum has been serving and saving power plants the world over for twenty-three years. That serving and saving is available to you.

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AMERICAN SAND-BANUM COMPANY, Inc.
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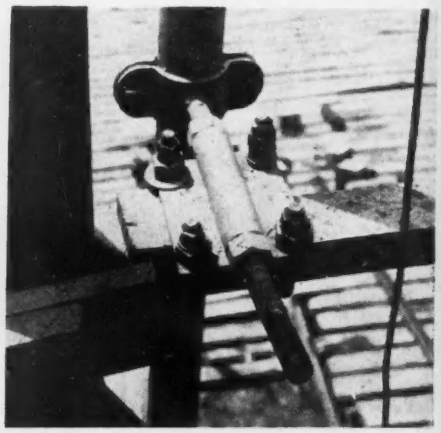
HOW TO— Clamp Standpipe Outside Derrick to Save Space

Considerable space can be saved on the derrick floor by placing the standpipe on the outside of the derrick and locating the valves where they are easily accessible. This space-saving method was employed on one Gulf Coast steam rig where a 24-foot base derrick was used. In placing the standpipe on the outside of the structure, it was necessary to alter the manner in which the standpipe was anchored to the derrick.

The device illustrated was fabricated



to serve as the standpipe anchor. Heavy U-bolts clamped around the derrick girt hold a flat steel plate in place. To the center of this one-fourth inch steel plate was welded a one inch piece of pipe as shown. The adjustable part of the anchor device was made from a three-fourths inch bolt about 20 inches long. The head was cut off and the bolt was welded to one of the half sections of a saddle clamp which was also fabricated by the machine shops from plate steel. This clamp is held on the standpipe by two bolts, one on either side of the clamp.

When the bolt was inserted into the anchor piece, a hex nut was first screwed up to the pipe clamp. A second nut holds the bolt in the pipe section. The distance the standpipe is to be held from the derrick can be adjusted accurately by taking up or unscrewing the nuts on the threaded section of the bolt.

This anchor device is removed from the pipe by unbolting the two pipe clamp bolts and the U-bolts on the derrick girt. There is one such device for each girt for the full length of the standpipe. They have proven satisfactory in making minor adjustments from one location to another.

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COMBINATION
RIG LIGHTING PLANT
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AIR COMPRESSOR
WASHDOWN PUMP

Here is a completely new *all-electric* utility unit consisting of an engine-driven (either diesel or gas / gasoline / butane) lighting generator, a centrifugal water pump, an air compressor and a built-in welding generator.

ALL-ELECTRIC DRIVE. All accessories are individually driven by splash proof, ball bearing electric motors (of standard make) thus eliminating the necessity of line shafts, pillow block bearings, flexible couplings and line shaft clutches which require lubrication, frequent alignment and many other troublesome service difficulties commonly associated with mechanically-driven units.

GREATER FLEXIBILITY. Since each component is individually driven, the speed of each can be changed without changing the engine speed or interfering with lighting.

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HOW TO— Add Clutch Pedal

The many controls which the driller must manipulate during "going in the hole" with drill pipe require careful and precise coordination of feet and hands. The accuracy with which he is able to operate these controls at the proper time

LOW COST PER UNIT OF WORK

Suppose you're considering two competitive brands of wire rope. They look alike, but one sells for a little less than the other. Bargain? Often it's anything but a bargain. For purchase price alone isn't the measure of wire-rope economy.

Sometimes you may find a wire rope with a lower price tag than Bethlehem's. But how does the cheaper one compare in total service rendered? How about its *Cost per Unit of Work?*

What a unit of work is depends, of course, upon the industry involved. It can be a ton of rock moved by a power shovel. Or a car of coal hauled up a slope. Or a ton-mile in oil-country rotary drilling. But in any case, unless your final rope Cost per Unit of Work is *low*, the rope has not done an economical job for you. That's why first cost—purchase price—isn't the sole yardstick.

Bethlehem wire rope is a quality product, one conscientiously built for long-range economy. When you buy it, you are spending your money wisely. You are buying wire rope that means, in the truest sense, *low* Cost per Unit of Work.

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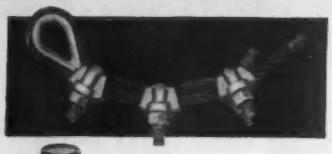

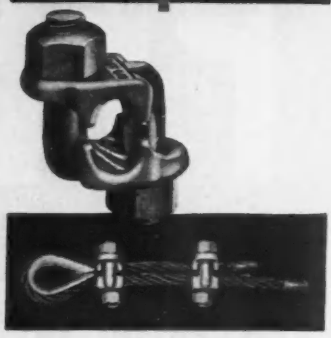

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SAFETY CLIPS OFFER YOU

ALL THESE SAVINGS:

- Fewer clips required . . . money saved
- No crimped, bowed rope . . . rope saved
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- No battered threads . . . bolts saved
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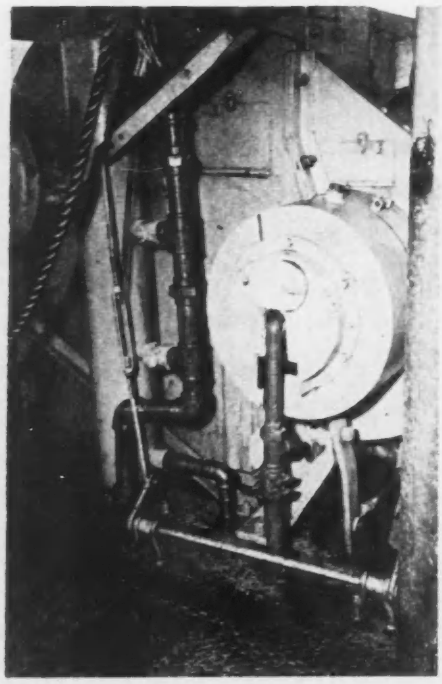
LAUGHLIN

THE MOST COMPLETE LINE OF DROP-FORGED WIRE ROPE AND CHAIN FITTINGS

DRILLING HINTS

is almost directly proportional to the time and degree of safety of these operations. On the particular rig illustrated, the driller's controls were brought closer together and a linkage added to transfer the operation of the cathead clutch from a hand movement to a foot control. By making the cathead clutch a foot control operation rather than a hand control job, the driller's left hand is free to regulate the steam engine more closely. His right hand, of course, is on the draw-works' brake.

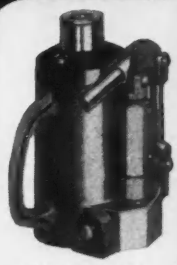
Holes were drilled in the clutch lever of the cathead to provide adequate leverage for foot manipulation. A transfer linkage was attached by bending a half-inch bar and fixing it to the lever with a cotter pin. A turnbuckle provided a means of adjusting this linkage to the proper stroke as the clutch showed wear. Vertical motion was transferred to a horizontal rod through a lever arm supported at the end of the rod by half a link of rotary drilling chain which had been welded to the steel floor plates.



A similar bearing shown at the right end of the horizontal rod, was provided near the driller's position. Another right-angle lever was welded to the rod and a foot pedal added. This linkage provided sufficient leverage so that the driller could apply as much force to the clutch plates on the cathead with his foot control as he previously could with the hand lever control. The hand lever remains for use whenever it is required.

CUT TIME, CUT COSTS on TOUGH PULLING JOBS

Jenny pulls through center hole — torque is eliminated, power added.



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Use the Hydraulic, No-Twist Power of the Simplex-Jenny

Makes even the most difficult pulling jobs an easy job for one man. Unique center hole action speeds pulling of valve seats, keys, wheels, gears, wrist pins, cylinder liners etc. The Simplex-Jenny is self contained, light in weight, but built for rugged, lasting service. Can also be used as a press (all models tapped for gauges) or as a conventional hydraulic jack.

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A Torsion Balance survey by our method is what you need to interpret your gravity anomalies when other means fail. The Torsion Balance has **high resolving power, eliminates regional effects naturally and easily by virtue of its resolving power,** and is **truly exclusive.** There is **very little likelihood** that the balance survey you undertake **would duplicate** anything **now** in **the files** of your **competitors.** The balance, **if properly used,** is especially well adapted to **fault** and **reef** problems.

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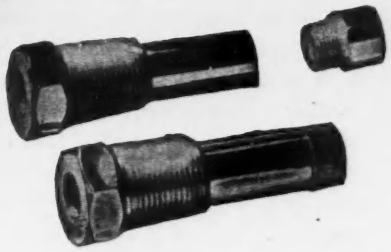

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Unique design permits replacement of inserts instead of the entire plug. OSECO "Silver Top" plugs are made in all standard sizes of best quality bronze, under A.S.M.E. specifications for 300 and 350 lb. oil field boilers. They can also be furnished in Monel or Stainless Steel.

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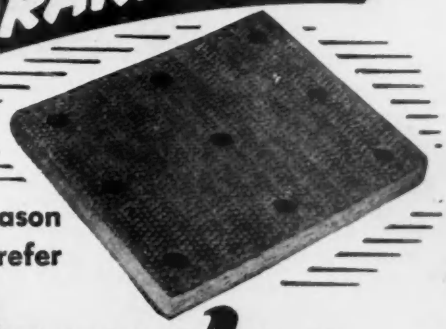

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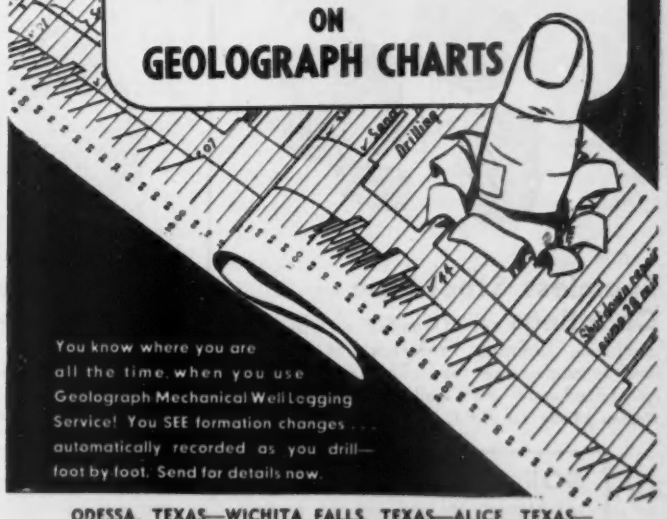

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For big engines that put out large quantities of heat through the exhaust, a rectangular metal covering over the muffler provides suitable protection for the canvas roof against the extreme heat dissipated from the muffler. It is simply a slightly curved thin sheet of metal cut to a size that will cover the entire muffler section. Purpose of this shield originally was to protect the hot

muffler from moisture in case the engine was left exposed.

This shield is attached to the muffler by a strap steel bracket which bolts to the saddle of the muffler support. Two strap steel legs welded to the shield at either end of the muffler hold it rigidly in place. It is a simple device that provides a guard against burning the canvas roof in case the roof is lowered on top of the muffler while it is still hot.

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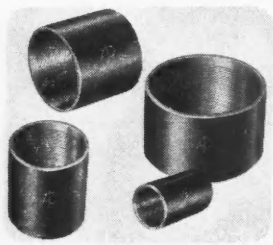

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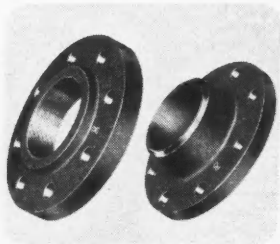

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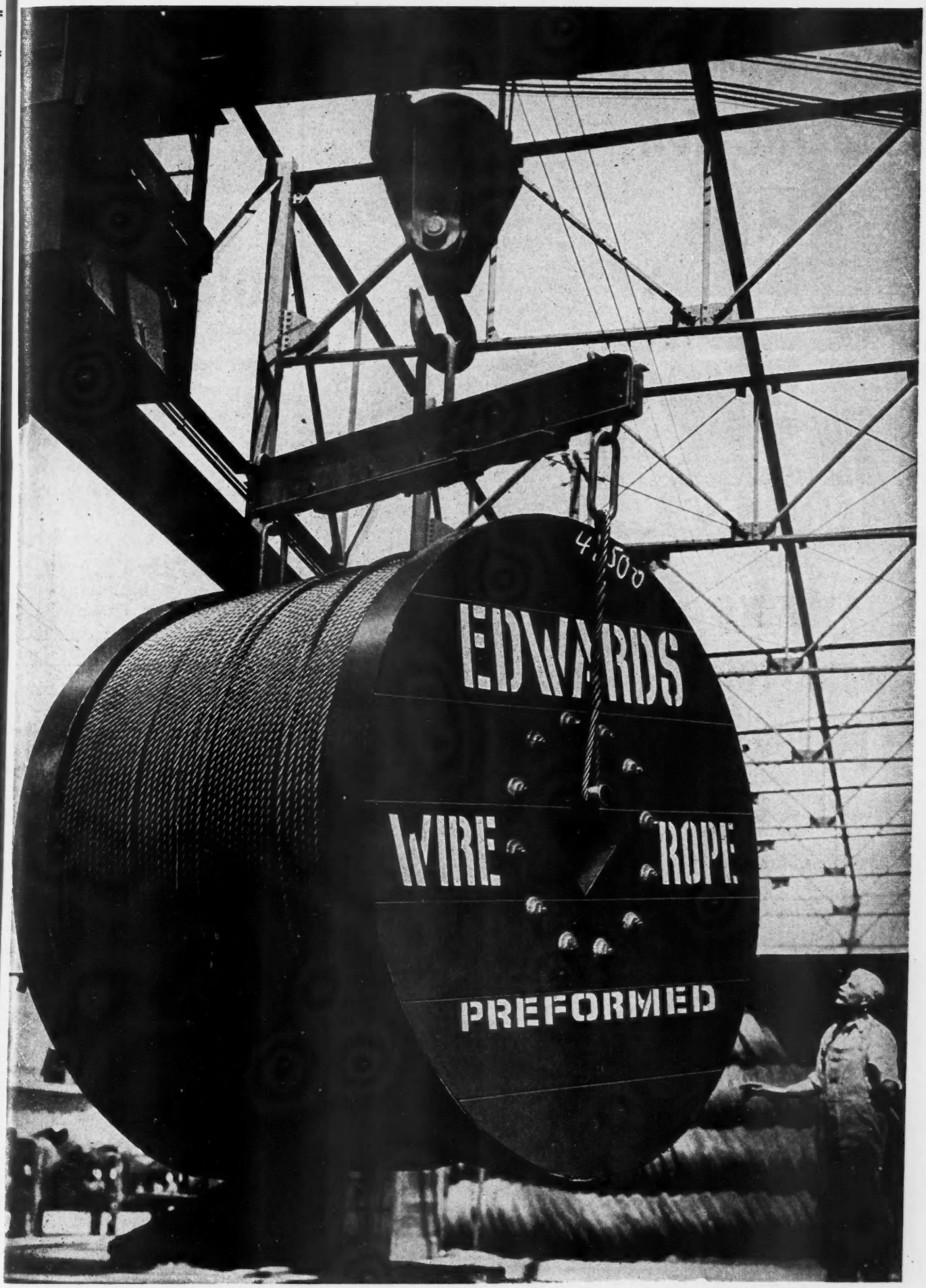
HOW TO— Support Stacks

Standard oil field boiler stacks are normally a separate unit and fit closely over the stack opening in the boiler shell. Unless the stacks are adequately



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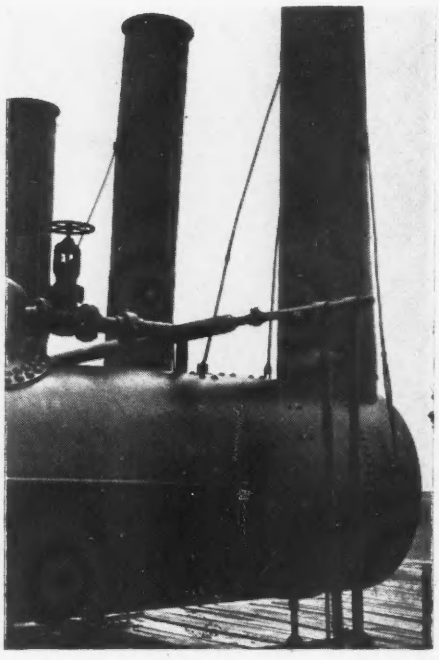
supported or guyed, high winds will blow them over. One method of securely holding the boiler stacks in a vertical position is illustrated. Not only does it lend sufficient support to the stack, but it is so made up that a minimum of time is required in setting them in place or dismantling the boilers for moving.

Instead of using guy wires, as is common practice in many areas, one-half-inch steel rods are employed. Each stack



is held in place by three such steel rods which are anchored to the boiler shell. The method of attaching the rods to the stacks and to the boiler shells utilizes right-angle bends of strap steel. Two such pieces are required for each connection, and are welded to the point of attachment. Holes are bored through the projecting ends to accept a pin fitted with a half-inch bolt. This bolt fits through an eye formed in the steel rod.

Minute adjustments in the stack position can be made once the unit is erected. Turnbuckles are incorporated in the rod sections so that takeup or extension can be made in the rods to position the stacks as desired. The simplicity of the supports make them a time-saving way of holding the boiler stacks in place. In dismantling, it is necessary only to remove the bolts at the connections on the boiler. These bolts are replaced in the connectors to prevent their loss.

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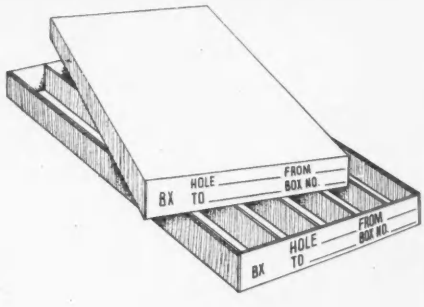

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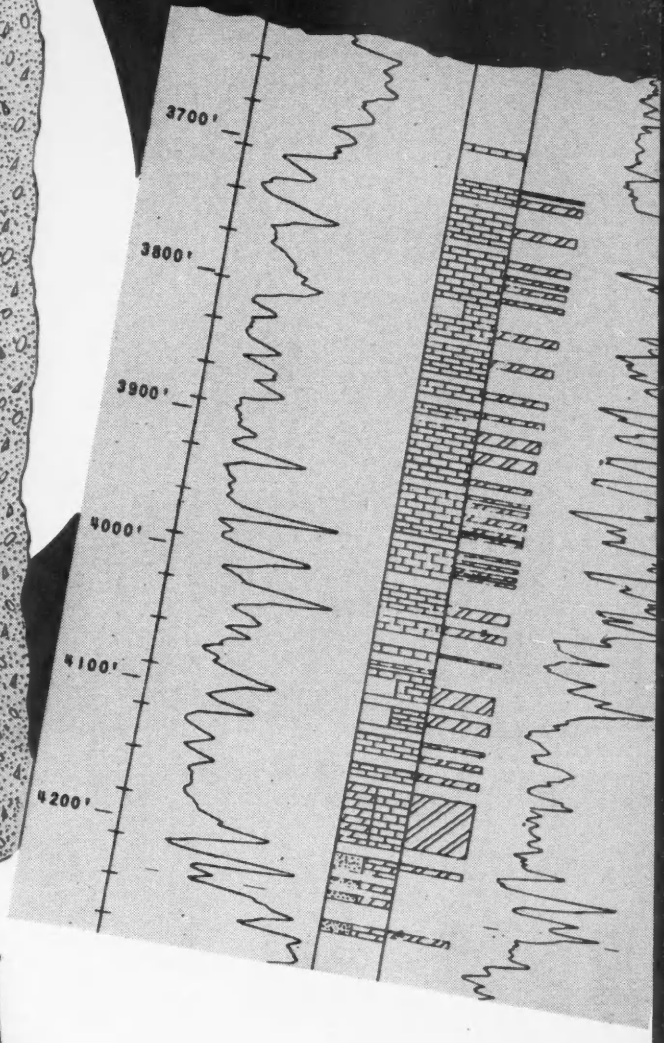

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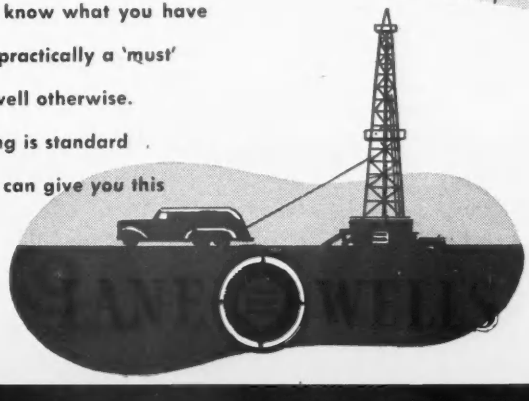

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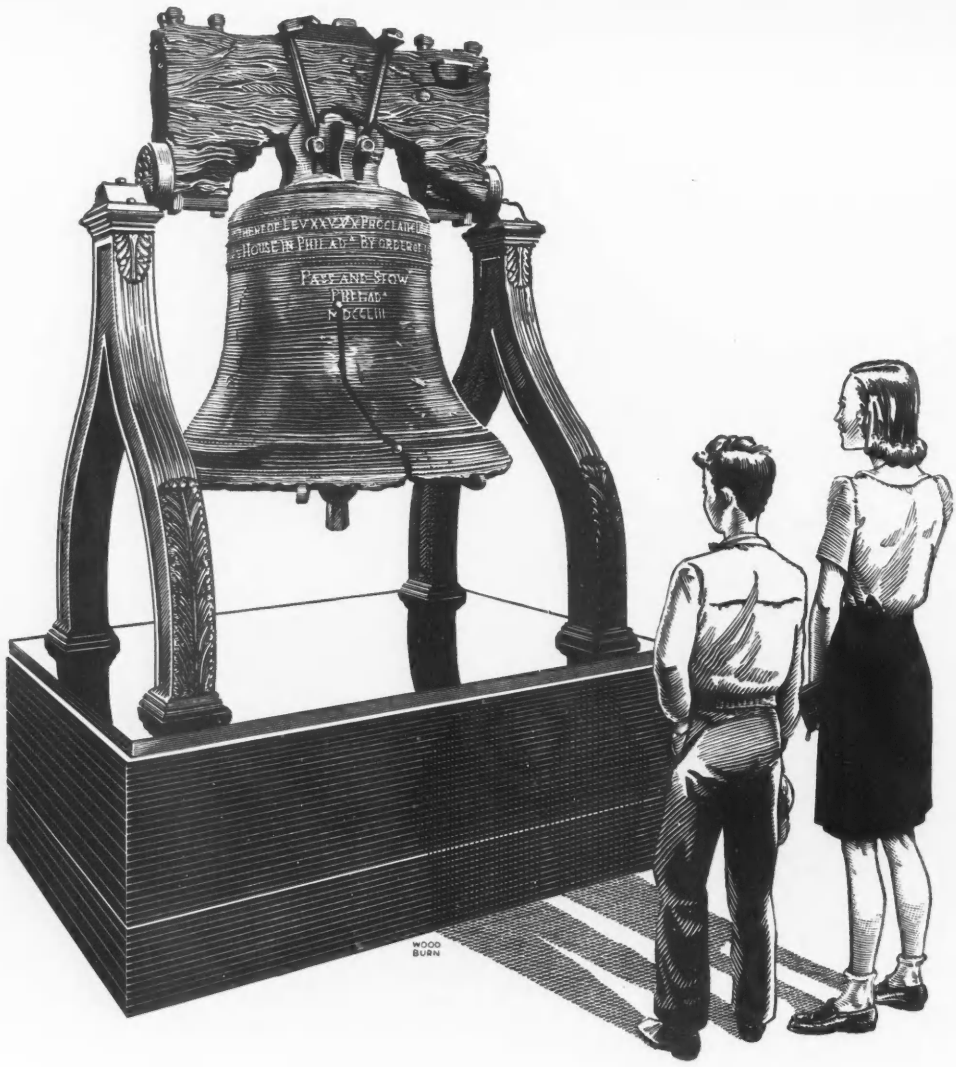

What price liberty?

IT was Daniel Webster who said, "God grants liberty only to those who love it and are always ready to guard and defend it."

Today in our yearning for "security", we are inclined to forget about that "liberty" for which this old bell rang out. The two are not synonymous. When we permit a benevolent government to assume more and more responsibility for housing, feeding, hospitalizing, and even entertaining our citizens, we must in return expect to surrender more and more of our personal rights and liberties.

Actually, the only security any man can enjoy with liberty is the security he earns through his own initiative, resourcefulness and productivity. As community leaders, it is our responsibility to help our fellow citizens realize that for the delusion of government-guaranteed security they are sacrificing liberty.

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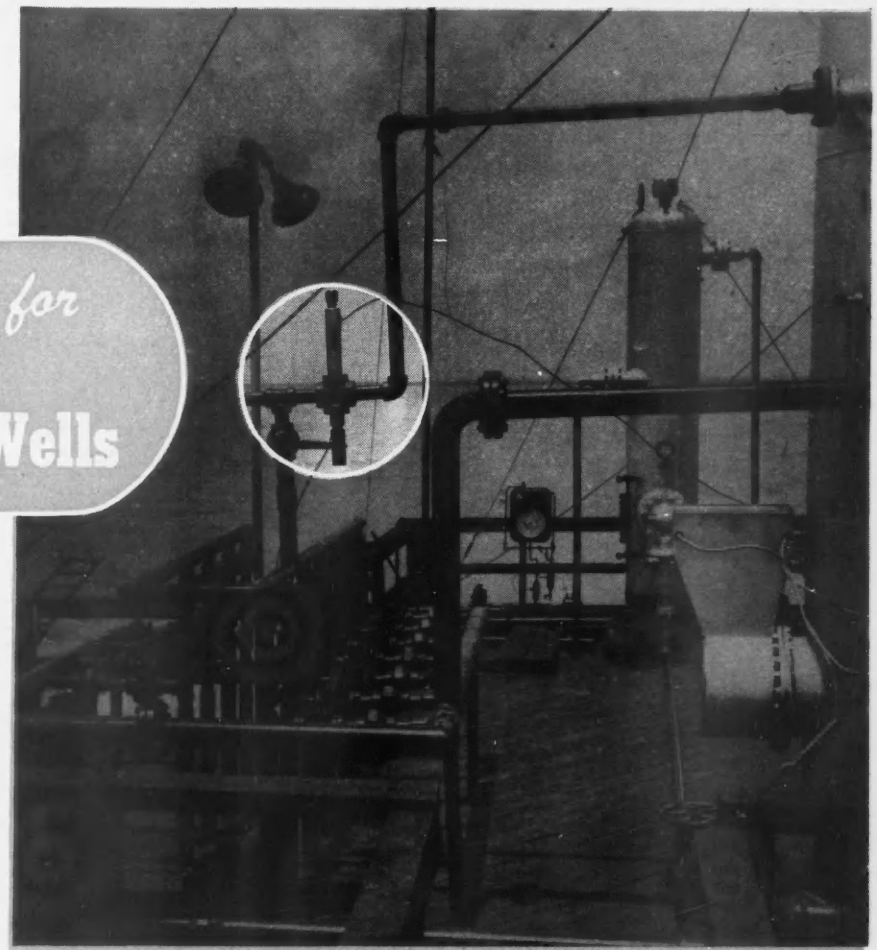
Unique Hookup for Testing Marine Wells



Flow lines from 13 producing wells tie into the stair-stepped, U-shaped manifold hookup. The upper manifold is used for testing individual wells, while the lower and larger manifold handles production from the field to the production separators. Encircled is the storm valve which automatically takes a well off test when the stock tank is full.

By J. E. KASTROP, Staff Writer

THE location of marine wells and their inaccessibility during inclement weather make it necessary to include safety precautions in production practices which are not generally required for similiar operations ashore. The advantage of locating a separator platform at a central point in marine fields has been well established. With all lines converging on the separator platform, only one large flow line is required to carry the fluid to a distant shore station, thereby eliminating individual flow lines from each well to a shore installation which may be many miles away. This practice is not uncommon among marine operators having production in lakes, swamps and bays where oil could not be safely stored in the field.

Such was the case with Standard Oil Company of Texas in its Smith Point field of Galveston Bay, Chambers County, Texas. This field consists of 12 producing wells about ten miles from the Cedar Point tank battery where the oil is treated and stored. A separator platform was centrally located in the field to remove gas from the fluids before flowing them through a six-inch line to the shore tank battery. One well from the East Red Fish Reef field is also flowed into the separators on this platform, making a total of 13 wells producing into this central point.

In addition to the separators, a well-testing system was installed on the platform, and included a large test separator, a 500-barrel stock tank, manifolds, orifice meters, regulators, etc. This testing system is necessary so that each well could be checked periodically to determine its performance. Each well is permitted to flow during the test for a period of 24 hours, after which fluid within the 500-barrel stock tank is measured and then pumped into the six-inch pipe line by a small gas-powered reciprocating plunger pump.

There are two features which make this well test hookup unique in production practice. The manner in which each well is connected into the testing manifold is unusual. Representing unusual ingenuity is a special safety device which prevents the stock tank from overflowing. This precaution is necessary to prevent pollution of bay waters. Experience has indicated that such a device is mandatory, since high winds, squalls and heavy fogs would, in many cases, make it impossible for the pumper or gauger to return to the platform within 24 hours after the test was started.

There have been occasions when a well was placed on test during clear weather, followed by a storm which prevented anyone from returning to the platform for several days.

Testing Manifold

Fluid from each well can be directed into one of two flow paths. Under normal production operations, fluid from all wells flows into a four-inch pro-

duction manifold which carries it to the production separators. Any well can be placed on test by opening a plug valve leading to a 2½-inch test manifold, shown as the upper U-shaped manifold in the illustration. By stair-stepping these manifolds in a U-shape, considerable space has been saved, and the pumper or gauger can easily determine at a glance which well is on test.

The test separator holds only 100 pounds back pressure on the test manifold, while the production manifold flowing fluid from all wells has a back pressure of approximatetly 150 pounds per square inch. Each flow line leads into the production manifold through a plug valve and combination union check valve. Fluid will flow into the production manifold so long as the flow line pressure is 150 pounds or more. If the well pressure should drop below this value for any reason, back flow would be prevented by the check valve in the union. This check valve serves another purpose in testing the well.

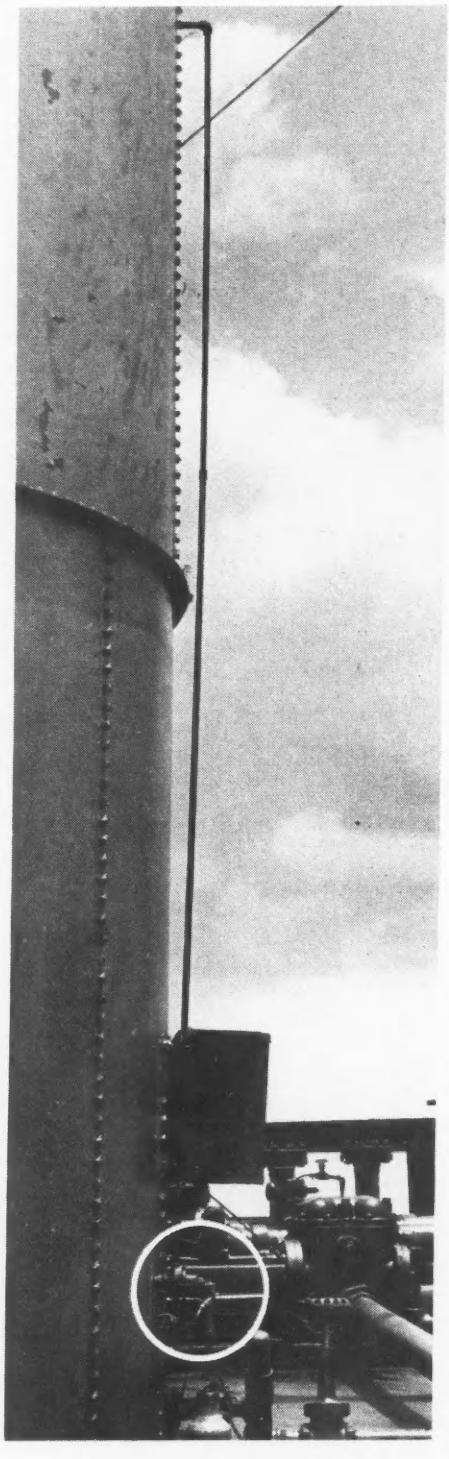
Two Paths for Fluid

When a well is placed on test, its flow into the production manifold is not blocked off as would normally be expected. Instead, the fluid from the well under test can take either of two paths: into the test manifold, or into the production manifold. Since the test separator holds only 100 pounds back pressure, a differential of 50 pounds exists across the union check valve when a well is open to the test system. This pressure differential is sufficient to hold the union swing check valve closed and it will remain closed while this differential exists. However, if the flow of fluid into the test separator were blocked, the well on test would continue to produce, not into the test stock tank, but into the production manifold and on through the production separators to the shore tank battery. In this manner, each well is allowed to produce continually, even during storms, when the test system is blocked automatically after the test stock tank has been filled.

Safety Shutoff Device

A safety shutoff device was incorporated into the testing system to prevent the test tank from overflowing in the event bad weather made it impossible for the pumper to return to the separator platform to stop the test. Heart of this safety device is a small pressure diaphragm regulator and a storm valve which has been adapted for this purpose.

The storm valve is shown mounted horizontally in the 2½-inch line from the test manifold to the test separator. Essentially, it is a ball that is held above the flow stream inside the valve body. A seat for the valve is inserted in the downstream side of the cross. A piston-actuated plunger in the upper section of the valve pushes the steel ball into the flow stream when sufficient pressure is applied on top of the piston element.



Control device of the automatic shutoff mechanism is shown encircled at the bottom of the 14-foot column of three-fourths inch pipe. Head pressure developed at the bottom of this column actuates the controlling valves which cause the storm valve in the test line to close.

The ball, once in the flow stream, seats itself against the tubular insert to shut off the flow of fluid through the valve. The storm valve will remain closed until line pressure is bled from the upstream side and the steel ball manually returned to its seat above the flow stream through the valve body.

Gas pressure which actuates the piston in forcing the steel ball into the flow stream of the valve body, thereby blocking the flow, is controlled by a small needle valve. A lever was added to the stem of the needle to provide the necessary leverage to open the valve, which is normally held in the closed position.

Controlling Mechanism

The controlling mechanism which trips this small needle valve is a pressure diaphragm regulator mounted at the bottom of a 14-foot section of three-quarter inch pipe. The regulator is screwed directly into the tank about 20 inches above bottom. The top of the pipe column is tapped into the tank approximately two feet from the upper edge. As fluids flow into the tank and the surface rises, a hydrostatic head is developed inside the three-quarter inch pipe column. This head of pressure forces the diaphragm of the regulator outward, causing its stem to contact the lever arm on the needle valve.

When fluid level approaches the top of the three-quarter inch pipe column, sufficient head pressure is developed to cause the diaphragm regulator to trip the needle valve, gas pressure applied to the storm valve, and flow of fluid into the test manifold is stopped. The flow of fluid from the well continues, and when pressure in the flow line builds up to 150 pounds, the check valve opens and fluid is permitted to flow into the production manifolds. Gas to actuate the storm valve is supplied by a tap to the gas outlet on the production separators.

Conditions are returned to normal only after fluid in the stock tank has been removed by the gas-powered plunger pump, and the head pressure on the diaphragm valve is lowered. Then, a plug valve below the storm valve is closed and pressure bled from the storm valve body. The ball can then be returned to its seat manually, and the system made ready for another well test.

The safety device described here, while rough in its present appearance, has proven its worth in more than one instance. It is another example of the ingenuity which makes the continuous production of oil from these remote marine wells possible and profitable.

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DEVELOPMENT OF a down-the-hole metering device for accurately registering the amount of water being delivered to the formation enables operators to check the performance of individual wells and thus to regulate the distribution of flood water for most advantageous per well inputs.

Telefloodmeter

Measures Input Water

By O. L. PATTERSON
Sun Physical Laboratory, Newton Square, Penn.

J. R. VAUGHAN, JR.
Sun Oil Company, Evansville, Ind.

and

Q. B. MARSH
Sperry-Sun Well Surveying Company, Crossville, Ill.

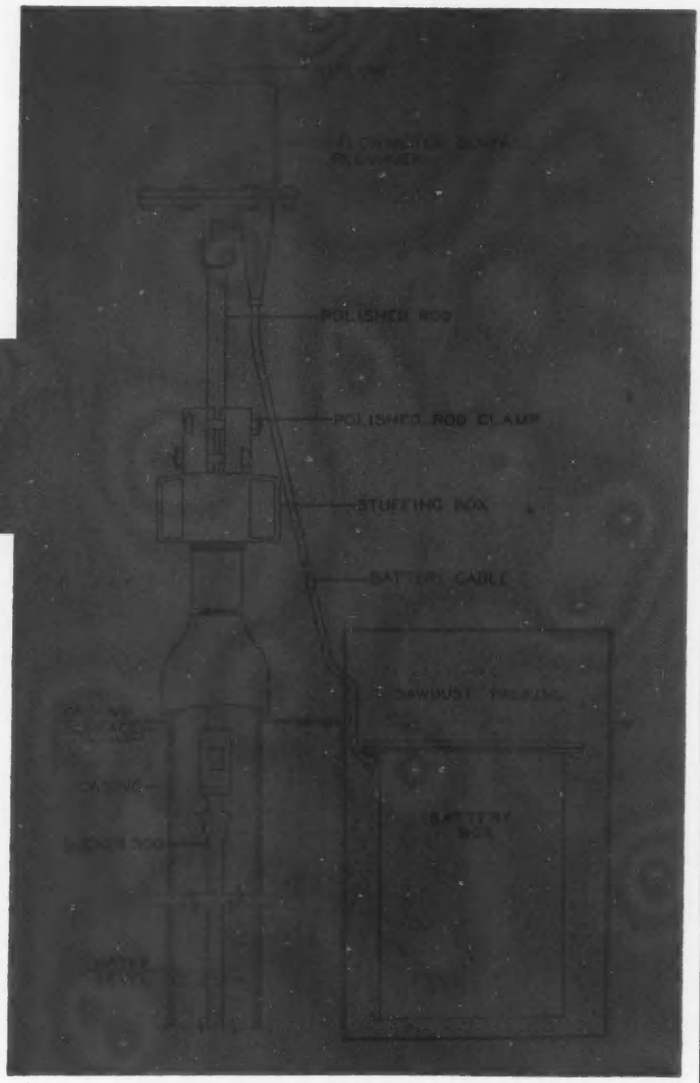


FIGURE 1. Details of the surface equipment composing the new Sun input well flow meter.

THE rate at which water is injected (or "dumped" from perforations) into an input well is of prime importance to the operator. If sufficient data have been collected from past experience and a good knowledge of the characteristics of the formation to be flooded is available, the operator can predetermine what should be the most efficient injection rate. If there is little information available, a conservative injection rate can be established and the results observed.

The injection rate often is the controlling factor which will determine whether or not the water-flood program will be a successful one. Too low an injection rate may prolong the life of the flood to such an extent that it is not profitable to operate the property. Too great an injection rate may cause premature channeling, which will result in increased produced water and in many cases will decrease the oil production.

When offset wells start to produce injected water, it is well to know the amount of water being injected. This information is necessary for the operator to determine how much, if any, of the injected water is advancing toward other wells in the project. It is possible for one offset well to produce most or all of the injected water. If such were the case and the operator was not aware of this due to lack of information on the injection rate, his flooding program would be at a standstill and many months might be wasted in guessing where all of the injected water was going. When sufficient data are available on the amount of water being injected and on the amount of injected water being produced, corrective measures can be attempted, such as decreasing the injection rate, use of plugging agents in the channeled or flooded-out zone, or "closing-in" of the well which is producing the high oil/water ratio.

The cumulative amount of water injected in any flood program is very valuable, and is determined from the daily injection rate. When the operator knows the amount of oil, water and gas produced from a formation and core analysis data are available, he can approximate the amount of water that must be injected before any results should be noted in offset wells. If results are observed much sooner than expected, the operator might suspect channeling which would result in a rapid water encroachment. On the other hand, if the cumulative water injection was in excess of the total oil, water and gas produced, the operator can suspect that the zone in which the water is being injected may not be continuous with the zone which is producing in the offset wells.

It is difficult to place a monetary value on the information obtained from knowledge of injection rates; however, all operators are aware of its importance. This is obvious due to the large sums

of money and time that have been spent by many operators in developing and working with various methods to determine and control injection rates. In the past, some operators have preferred to install surface injection systems whereby the injected water could be metered rather than perforate an upper water sand and allow the water to pass promiscuously down the casing into the zone to be flooded.

Individual Cases

Each water-flooding project presents an individual problem and it should be developed as such. Due to the many erratic conditions which prevail in lime formations, the best information available often is not adequate. However, an "educated-guess" based on all available information is much better than just a guess. The only means by which reliable information can be gathered is to have accurate knowledge of water injection rates.

The telefloodmeter developed by the Sun Oil Company Physical Laboratory seems to fulfill all these requirements. Operation of the meter is simple. The metering element is a vertical-shaft turbine of the impulse type. The turbine wheel revolves at a speed linearly related to the flow rate. A small portion of the energy developed by the moving liquid is used to compress a spring through a 1000 to 1 gear reduction from the turbine wheel. A stepped cam periodically releases this spring which drives a hammer against an anvil which is tightly coupled to the end of the sucker rod from which the entire assembly is suspended. The hammer blow creates an acoustic impulse which travels up the sucker rod to the surface where it may easily be heard by ear or optionally used to actuate the surface counter.

Figures 1 and 2 show the details of a typical installation. For this operation the inlet perforations were made opposite the Cypress sand to flood the producing horizon in the McClosky lime. In this installation a standard swab cup was used to provide a seal against the casing wall and thus force the water through the meter. Any of the standard packers may optionally be used if desired by the operator. A 3/16-inch orifice was installed in this well in order to limit the flow rate to a value below 500 barrels per day.

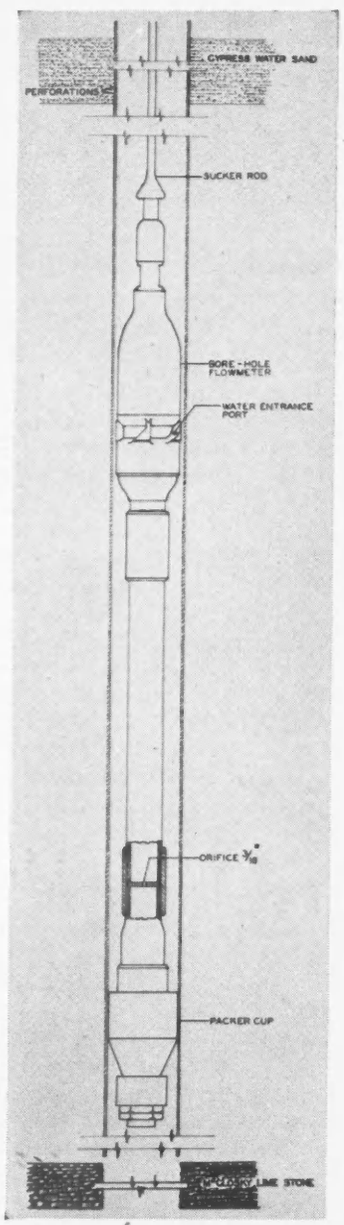
Figure 3 is a cross-sectional view of the meter assembly. The outside diameter is 4⅝ inches which permits it to be used in standard weight five-inch, or larger, casing. Ball bearings are used throughout. All bearings are immersed in a light machine oil and may be expected, therefore, to operate for long periods without appreciable wear.

The oil-water seal is the special feature of the design which makes the meter practicable. Since conventional seals would load the shaft excessively, a new type seal had to be developed for the meter. The use of this type seal assures that the well water will not gain access to the bearing surfaces and cause corrosion, and at the same time reduces friction to the point where small flow velocities may be metered.

Upper Chamber

The upper chamber, which contains all bearing surfaces, is filled with oil under pressure while the meter is in an inverted position. When the meter is placed upright and lowered into the hole, water passes through the annular space A and fills the lower chamber to approximately the level shown. The baffle and labyrinth system prevents intermixture of the oil and water. Such a seal provides, in effect, a nearly frictionless packing gland and has the added advantage of equalizing interior and exterior pressures, thus removing all limitations as to operating pressures.

A clearance of one-eighth inch has been provided between the turbine wheel and its housing. This was done to prevent sand particles from jamming and stopping the wheel. In laboratory tests, water carrying sand of grain size up to



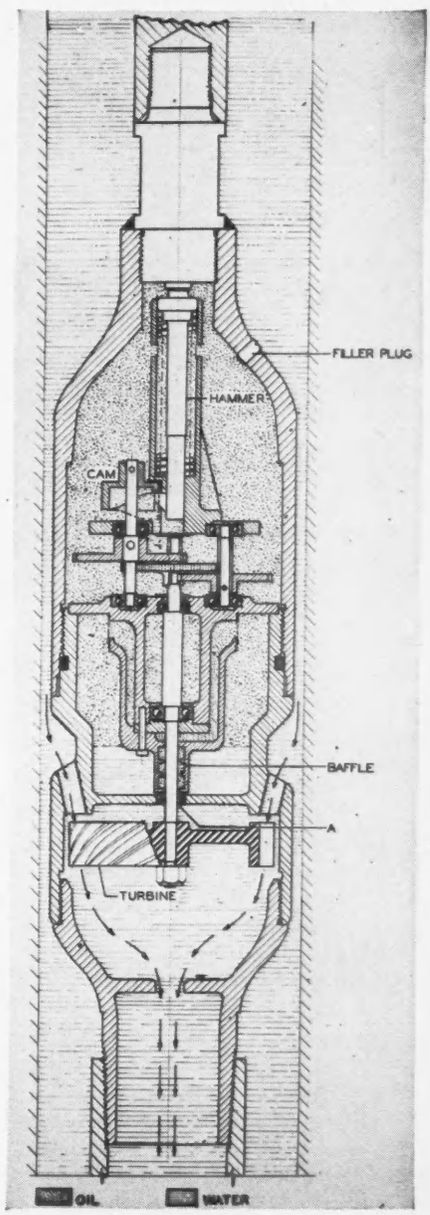


FIGURE 2 (left). Vertical cross-section of the installation from upper water sand down to producing formation.
FIGURE 3 (right). Internal construction of the underground meter; note portions of meter that are filled with oil and those through which the input water flows.

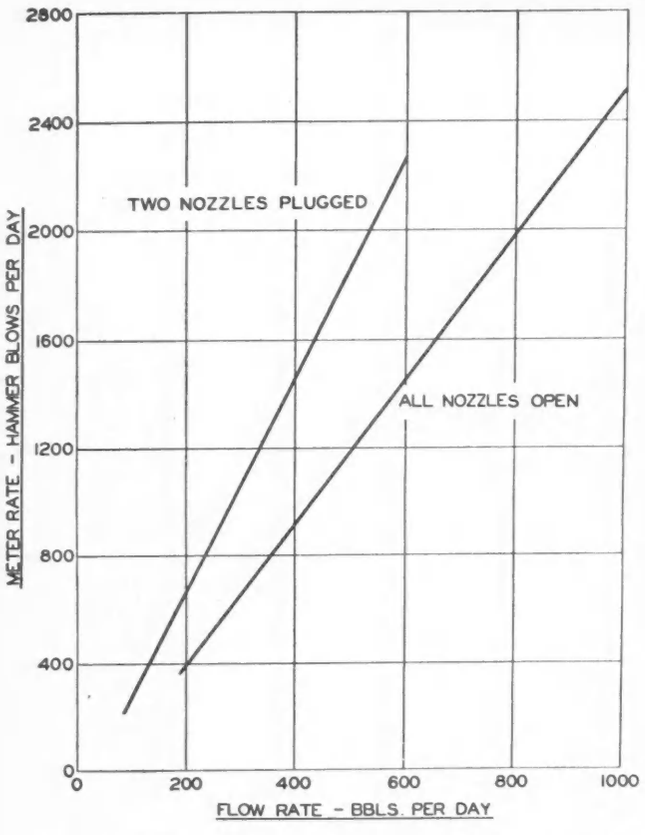


FIGURE 4. Relationship between "hammer counts" per day and water flow rate.

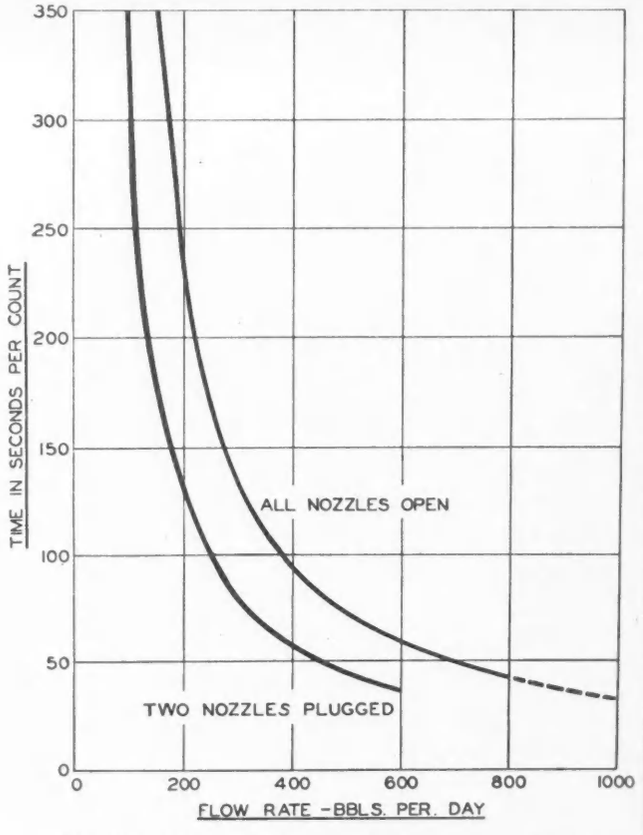


FIGURE 5. Relationship between time interval signals and flow rate.

one-eighth inch, was continuously circulated through the meter without any noticeable effect on the mechanism.

Range of Meter

The meter has been provided with four nozzles, some of which may be closed with plugs, depending on the flow range it is desired to cover. With all four nozzles open, flow rates between 200 and 2000 barrels per day may be metered. With two nozzles open, the range is 100 to 800 barrels per day, and with one nozzle, rates as low as 50 barrels per day may be metered.

Figure 4 shows the relationship between "counts" per day and the total quantity of water flow per day. The linear relationship existing between these quantities makes it possible to use this type of meter to integrate and register the total flow even though the flow rate is changing. Tests covering the flow rates shown in Figure 4 gave an error of less than 2 percent.

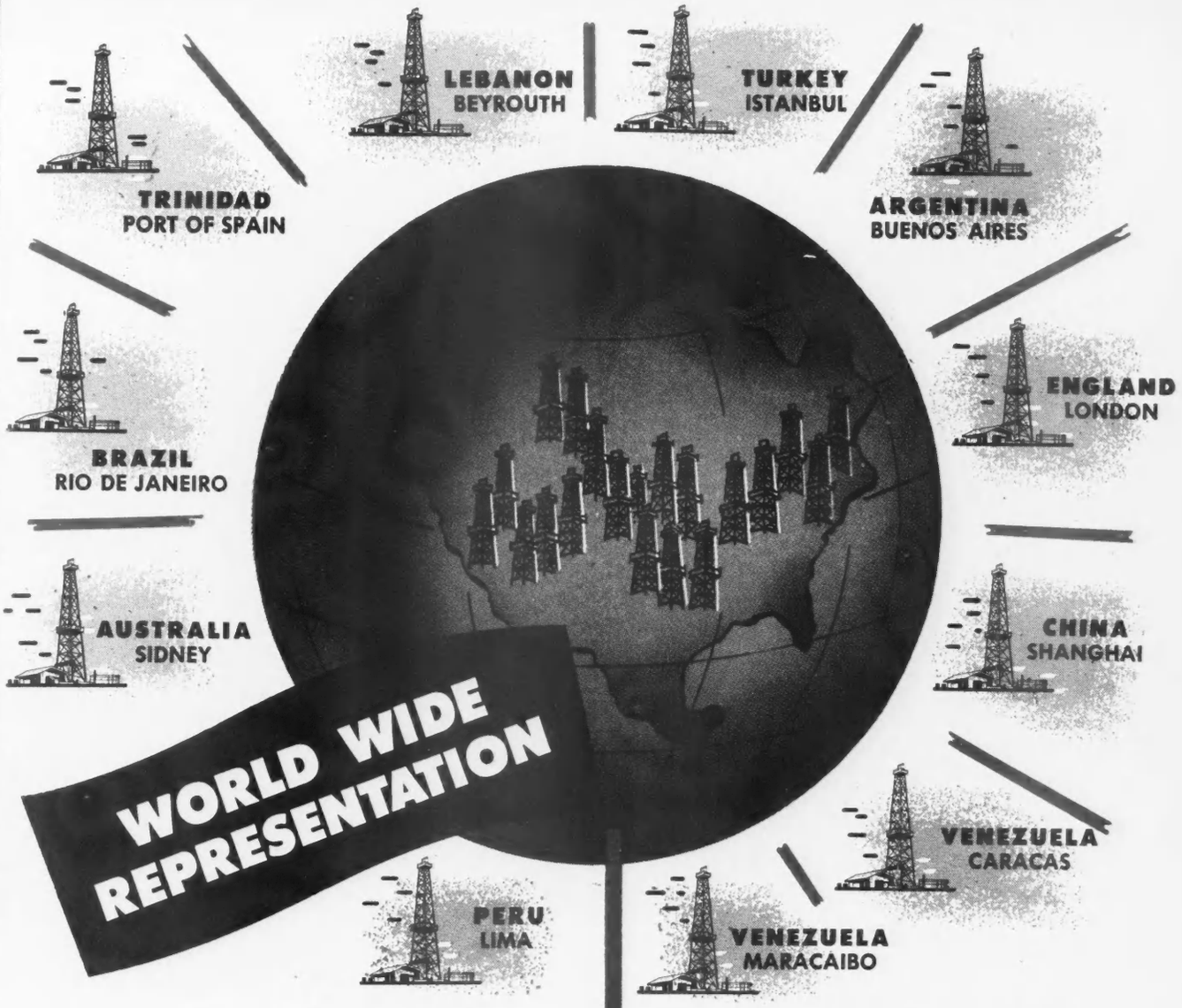
The surface recorder utilizes a piezoelectric crystal to convert the acoustic impulses into electric pulses which are amplified by a conventional electronic circuit. These amplified pulses are applied to a counter circuit which actuates a five-digit counter, visible through a window in the waterproof case. The total quantity of fluid which has passed through the flow meter may be determined by multiplying the counter reading by the conversion factor (number of barrels per count) as obtained from the calibration curve. The main feature of the recorder, which is battery operated, is its small power consumption of less than one watt. One set of fresh batteries will last six months to one year. The useful life of the batteries is affected by temperature and, therefore, they are placed in a waterproof galvanized steel box for installation below the ground surface to minimize temperature variations.

Measuring Time Interval

Since the acoustic impulses may be detected by ear, the surface recorder may be dispensed with if not desired. The rate of flow is then determined by measuring the time interval between signals with a stop watch and then referring to the curve shown in Figure 5. The frequency of making such flow-rate determinations will depend upon the desired accuracy of total flow measurement. Where maximum accuracy in the measurement of total flow is desired or where it is not convenient to make frequent flow-rate determinations, the surface recorder will be necessary.

Eleven installations have been made in Indiana, Illinois and Kentucky. Nine of these are flooding the McClosky limestone and two are operating in Cypress sand floods. These 11 meters have operated a total of 2895 days, during which time 628,750 barrels of water have been metered and injected into the flooding zone, for an average of 217 barrels per well per day. Injection rates vary from a low of 50 up to 900 barrels in their various installations. The first meter has operated 26 months without mechanical failure. During this period of operation, it was pulled twice for inspection and rate changes. After 15 consecutive months operation, the meter was pulled and the well acidized. Reinstallation was made and the well was materially helped by the acid job. Another installation is currently entering its 13th consecutive month operation without removal from the well. One meter was pulled after eleven consecutive months operation due to a broken spring on the cam shaft. Serious loss of sound transmission of the hammer blows from the meter to the surface resulted in the pulling of one of the early installations. Such failure was attributed to corrosion in the pins and boxes of the rod string, due to improper seating of the shoulders.

Five installations have been made in



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Kansas. Four of these installations were suspended on tubing, three of which are using the hook wall type packer. These were the first installations completed on tubing and the sound intensity of the hammer blows as transmitted through tubing is slightly less than that received through sucker rods. Indications are that the telefloodmeter application in Kansas and certain areas of Oklahoma and Texas will equal the success of these in the proven tri-state area.

Bridging plugs were set below the zone to be perforated on two installations in the tri-state area and efforts made to secure a good clean hole. In these two installations, the meters have operated for a combined total of 630 days without any failure, as against 120 days for one well in which the failure of the meter was attributable to scale plugging the ports of the meter.

On three installations where special sucker rod preparation recommended below was employed, the signal received at the surface from the hammer blows, after a combined operational period of 730 days, is still sufficiently strong to operate the surface counter unit and is quite audible to the naked ear at some distance.

Well Completions

Proper well completions on a well to be converted to water-flooding, where the installation of a telefloodmeter is applicable, should receive attention comparable to completion of a newly drilled oil well. Considering it from the standpoint of recoverable oil, a secondary recovery water flood well assumes vast importance. The success or failure of the flood depends, to a great extent, upon the manner of completion.

The simplest method of installation would merely consist of perforating the water sand in the well, running the telefloodmeter on a packer cup assembly, suspended from a sucker rod string. This method might work well in numerous cases, but most floods being started are in old fields which have been proportionately depleted by primary methods of recovery and very little information is available on the characteristics of the water sand which will supply the flooding water. The condition of the pipe is doubtful and such an installation in this type of well could, to a large extent, materially affect the efficiency and success of the flood, should excessive amounts of sand, scale, rotary mud and cement be permitted to enter the flood zone.

In such cases it might be well to give careful consideration to a method of installation, at least on the initial well, which has proved very successful and probably the least expensive from an over-all viewpoint. A drillable plug, available through most perforating companies, can be set easily at the time of perforating water sand. This assures the operator of a complete sealoff from the flood zone, preventing any properties from entering that zone until their characteristics are known and proven harmless to the flood zone.

In this manner, the cleanliness, purity, sand content and character of the water source can be determined. With the use of a temporary bridging plug, the operator can easily remove scale and corrosion from the walls of the casing, thus preventing this from entering the flood zone. The running of a swab should remove excessive amounts which are likely to be a source of trouble, and will indicate the condition of the pipe through the perforation zone.

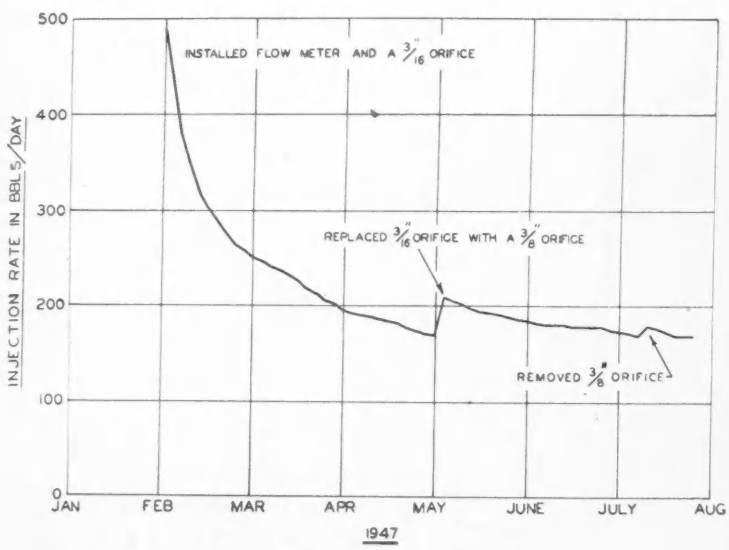
The plug can then be driven to the bottom of the hole or drilled up in a very short time.

Sucker Rod Preparation

The sound transmission, from the telefloodmeter to the surface, travels up the sucker rod string on which the meter and packer assembly are suspended. Extensive field tests have accentuated the utmost importance of proper preparation of the pins and boxes of the string to insure long periods of operation without an appreciable decrease in the intensity of the signal received at the surface. The greatest loss of sound occurs in these connections.

Should this loss of sound completely blank out signals received at the surface, the meter might well be classified as not working and a pulling job result. If the operator plans the application of a surface counter unit, it is doubly important that this loss be minimized.

As a result, a definite method is recommended for proper preparation of the pins and boxes. It has been fully tested. When old rods are used, the pin end should be polished around the shoulder with emery cloth strips or a rotary wire brush, thus removing all rust which could break the points of contact for sound transmission. The seats on the box should likewise receive the same application. To these surfaces zinc thread lubricant should be applied. When running the rods, a good seat must be established to prevent seepage of salt water and subsequent setting up of corrosion. This procedure, if carefully followed, will eliminate the extensive loss of sound. The rods should be "snapped up" at least four times.



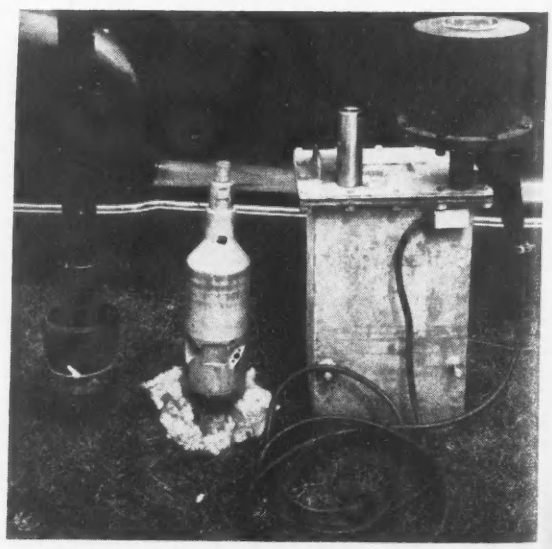


FIGURE 6 (left). Graph of injection rates showing effect of varying orifice sizes on water input.
FIGURE 7 (right). Elements of the telefloodmeter, from left to right: packer cup, telefloodmeter, battery box, counter mechanism.

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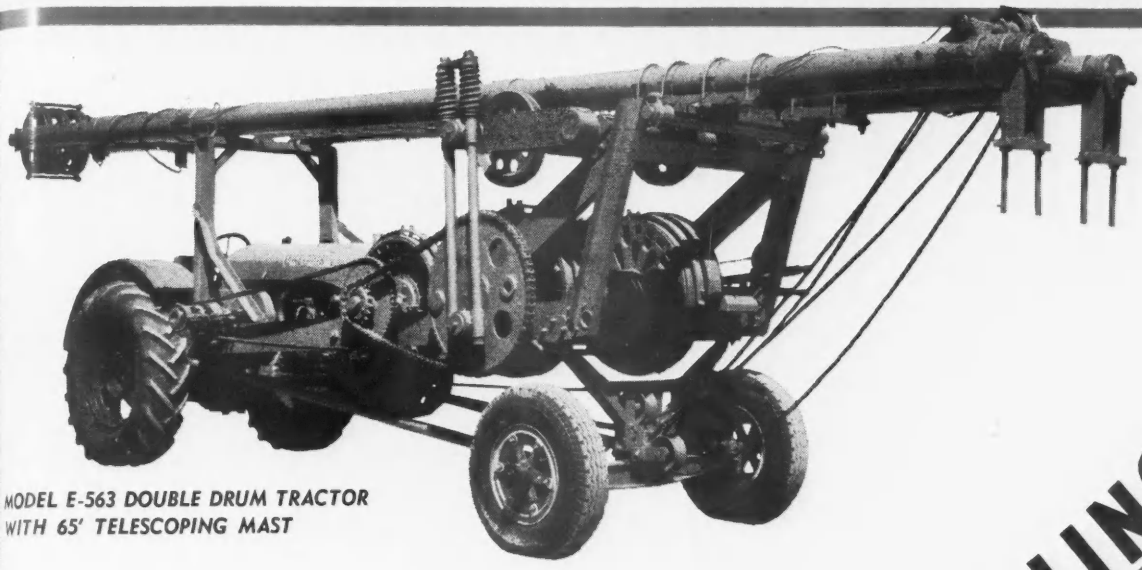

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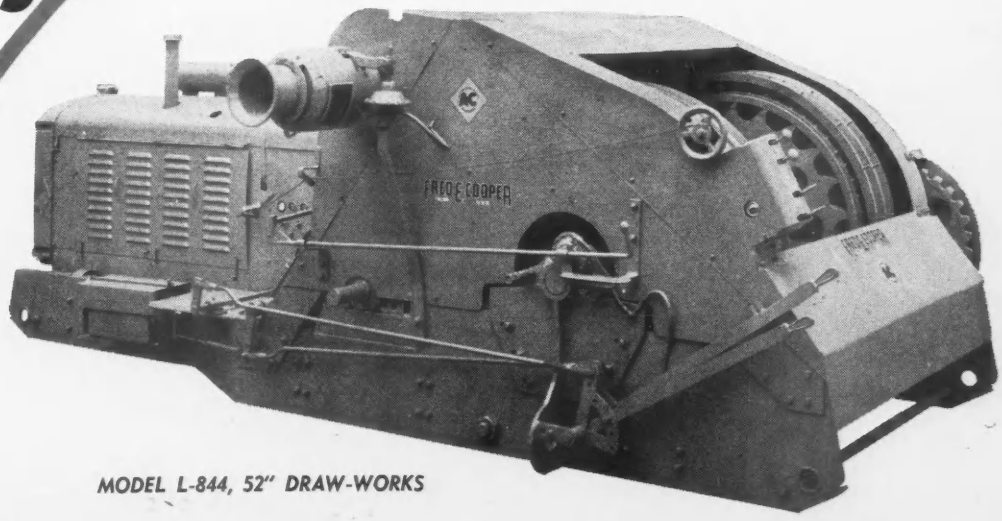

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PROCESSED WELLS Aid Oil Recovery

By F. R. COZZENS
Field Foreman, Equity Oil & Gas Company, Stockport, Ohio

THE most elusive and generally the most expensive oil to recover by any secondary process is migrant oil, which is conveyed through a formation by intricate actions beyond mechanical control. Much more oil migrates uncharted through an artificially pressured acreage of sand than is commonly realized, and quantities are invariably greater on leases where widespread and random abandonments of depleted strippers have been carried out.

The migratory trend is cleverly revealed on such leases when, in the course of secondary development, new wells drilled in the near vicinity of abandonments produce fresh, lively oil that was not present when the old wells were plugged. This new oil is due, not to the margin of virgin pay between the bores, but because in depleting the old well an area of low pressure was created, into which oil has migrated from zones of greater resistance. Had the old well been saved, but not operated during the period, the same receptive area would have existed, and incoming oil could have been recovered without drilling a new bore.

Oil movement into, and through areas thus created by primary depletions has a very definite influence on the behavior of secondary measures, and unnecessary abandonment of the old wells which caused the condition has very definite effects also upon the cost of applying secondary measures. No operator can be censored for excluding irregular and badly spaced old wells when shaping his pressure patterns, but he loses future assets when he excludes them entirely from his pressuring schedule. Many excluded wells, if given a chance, will produce more oil in the latter stages of pressuring than actual members of a precise geometric pattern, mainly because they have more effective contact with migratory trends. Or, they may prove later to be strategic induction points for driving transient oil to within range of regular producers. These facts have demonstrated themselves so forcibly on many pressured projects that it is now becoming an established field practice to conserve as many depleted wells as possible, regardless of location, and to process them into a dormant state during the early stages of secondary pressuring. Such processed wells are commonly termed 'zombies' because they are mechanically deadened producers which can be revived at the owner's discretion.

The primary need for this type of well arises from dissimilarities in pressures which originate when compressors are used to replace driving energy formerly contained in the sand reservoir. Natural reservoir energy did not radiate from certain fixed points, but was distributed through the sand in accordance with permeability variations, directional flow trends, and other courses of oil migration which are formed naturally by structural characteristics. Artificial energy must, of necessity, be inducted through surface arranged patterns which do not always coincide with these underground trends. Regulated well-spacing, in relation to induction centers, and combined with good shooting practices, tend to correct flow variations within a pattern to considerable extent, but engineering skill is by no means perfect. Much remains to be learned regarding structural flow trends within oil-bearing formations, and despite our best efforts, many naturally formed trends are only partially intercepted. Because of inadequate contact, unpredictable quantities of oil are conveyed through the sand beyond range of pattern-producers, and often within a very few feet of a fractured shot-hole. As pressuring continues, this oil either spreads out as 'streaks' over the project or accumulates in pools in receptive zones, and much of it will remain unsuspected in the sand unless favorable outlets are provided. No area is immune to the formation of such oil pools. They are found frequently in depleted gas caps at the top of a pay sand, and have been known to exist within 100 feet of patterns which were pressured and pumped for years. Where a processed well is already in position to intercept this oil, redrilling costs are saved and production is accomplished at a faster rate, with additional savings in labor and lifting costs.

THIS ARTICLE deals with the conserving and processing of depleted stripper wells for later use with secondary recovery measures. The need for such wells is now generally recognized, and the author describes most economic methods for processing, together with various uses which may be made of such wells after they are conditioned.

Any depleted well still capable of producing oil, or influencing the production of oil, is a qualified subject for processing, with the exclusion of watered-out wells, and those where badly collapsed pipe or other major impediment prohibits safe operations. All such wells should be plugged through each producing sand, and the bores filled to the surface with clay. History and exact location of every watered-out abandonment should be retained, however, because water is the only pressuring medium known that will induct itself into an oil-bearing formation. While self-induction is generally too slow for practical usage, it nevertheless creates a flooded zone of uncertain dimensions which cannot be obliterated from the sand.

The majority of depleted strippers, while usually water-coned to a certain extent, either by surface drainage or from leaks, in or around the casing, can be processed by one of three methods: (1) By using drillable plugs; (2) by running tubing or line-pipe on a packer; or (3) by inserting an inner string of casing.

The first process generally requires the use of cleanout tools, and is put into action by removing tubing and rods, measuring with steel line to de-

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termine the casing-seat, and running a dummy, or weighted line to estimate the amount of cavings in the shot hole. Liners, broken segments of tubing, etc., are fished out with a spear. The shot hole is cleaned of cavings and sand, and a drillable plug or substitute made on the job with drillable materials is then seated in the extreme top of the producing pay. If incoming water is caused by a bad shoulder, the casing is lifted five to eight feet with jacks, and a new shoulder is cut with an under-reamer. Where the shell is too thin, or other conditions prohibit the use of an under-reamer, the space between plug and casing is filled with cement slurry, a gel-type cement mixture being preferred. Before the cement has completely 'set' the casing is lowered (not dropped) upon it.

If any doubt exists as to the condition of the casing along the bore, a careful inspection is made before the cement and plugs are drilled through. Corrosive elements behind a string of casing generally reveal their actions by 'scabs' or scale-blisters which appear on the inner surface well in advance of actual leakage. These can be detected at any location along the bore by using a casing-scraper, run either on the drill, or upon the tubing and rotated with tongs. If suspicious evidence is located, the casing is ripped a few inches below the damaged point, and a quantity of cement slurry or one of the newer plastic compounds is squeezed through the opening by the use of tubing and a cement retainer. Occasionally, cement or plastic compound can be forced down the bore-walls, behind the casing, so as to close off shallow leaks and surface drainage. Major casing leaks, however, generally require removal of the entire string for effective repairs.

If the bore contains any treacherous open hole between casing shoulder and top of pay sand, these stretches are sprayed liberally with cement slurry, usually introduced by a spray-gun attachment on the bailer. In certain cases where special open-bore protection is necessary, a drillable bridging plug is seated immediately below the formation, and the bore is filled with cement slurry to a point one or two feet above it. When the cement has reached its initial set, the bore is redrilled, and if all repairs are completed, the entire bore is reopened into the shot hole. The shot hole is bailed dry as possible, and the well stands open for ten to twelve hours. If, at the end of that period, the oil shows no further evidence of fresh water, the well is closed in, and the casing is capped with a pressure head provided with gauge and release valve.

The second, and somewhat less tedious method of processing depleted strippers is carried out on wells having little or no accumulation of residue in the shot hole. Cleanout tools are seldom needed unless the casing requires special treatment, or is obstructed so as to prohibit the running of packers. The customary procedure is to pump the shot hole dry as possible, remove tubing for inspection and to replace weak or damaged sections. The rejuvenated string is then re-run on a packer, which is seated at the top of the producing pay, and backed up with 12 to 15 feet of cement slurry. Type of packer used is a matter of choice. With a wide variety of commercially-made packers to select from, it is comparatively easy to choose a type to fit any particular need. Position of the packer in the sand, however, is very important. If set too high, both fluid and pressuring medium are likely to escape through the formation immediately above the sand. If seated too low, some productive sand will be closed off. Many pioneer drillers determined the presence of a sand by the 'feel' of the drill, and casing shoulders, reducing points, etc., were calculated by 'flagging' the sand line. Such inaccurate measurement often caused the casing to be set a foot to 18 inches or more within the pay. These short stretches of undeveloped sand have on many occasions meant the loss of thousands of barrels of otherwise recoverable oil.

The usual procedure is to jack the casing off the shoulder to a distance three to six feet above the top of the first producing zone of sand. The original shoulder and intervening stretch of sand is then fractured with three to five quarts of liquid nitro-glycerin, or its equivalent in gelatin (solidified nitroglycerin). Tubing is then run and seated so the packer allows the fractured stretch to be included in the shot hole. After tests have shown that the packer has seated in the right position, the tubing is capped, and provided with release valve and gauge. Generally, the casing is removed, and space between tubing and wall is filled in to the surface with clay.

Final Method

The third and final well-processing method is somewhat a repetition of the second process, except that smaller diameter casing (usually four-inch) is run on packers instead of tubing. This permits the use of small cleanout tools if later reconditioning is necessary. It also permits running additional packers where certain sections of sand, shale lenses, etc., are to be zoned off. Casing packers are located and seated quite similarly to those run on tubing, the objective in all cases being to protect the shot hole against foreign interference, and to conserve the old well for future activity. On rare occasions, a depleted stripper will be found in top mechanical condition, so the only processing necessary is to cap the casing, and provide a gauge and pressure-release valve. All processed wells should be kept under observation, even though repaired and closed, because various chemical actions, bacterial growths, and deterioration can and do occur in non-agitated wells. The fact must be kept in mind that some of these wells remain in the dormant state for months, or even years.

It is assumed that each and every stripper well which has become an actual member of a pressure-pattern has undergone thorough reconditioning. The processed wells, not being members, are given only partial reconditioning, and are generally kept closed and dormant through the initial stages of re-pressuring. As pressures build up within the patterns, there is a stimulated trend of fluid flow toward the lower resistance areas. As these flow trends are intercepted, pressure action (as indicated by the gauge) begins to be observed at various random sites on processed wells. When this evidence, usually noticed first upon a processed well within a pattern or along its margins, becomes clearly defined the release valve is opened, casing cap removed, and pumping equipment is returned to the bore. The majority of reopened wells respond to pumping for indefinite periods as auxiliary producers, but as pressure build-up from the pattern inputs spreads and becomes more uniform over the project, resistance around the reopened wells also increases. Because of it, flow trends are further deviated, and processed wells at various isolated sites are more likely to respond. By the time the final wells are reopened and put on the pumps, some of the pattern producers have passed their peak in production. Backflowing, cross-pressuring, and other methods are then necessary to motivate the oil bank, and the reconverted wells serve as replacements, temporary inputs, stop-gap wells; and finally as 'blowout' (flowing) wells in releasing trapped oil during squeezing operations.

When a repressured project has finally reached its economic limits, each stripper well that was saved has the basic value that existed at primary depletion, the salvage value of casing, tubing, and rods. The margin of time saved by each well in secondary depletion has provided substantial interest on the investment, and the extra percentage of oil gained through the old bore, minus processing costs, was practically a gift.

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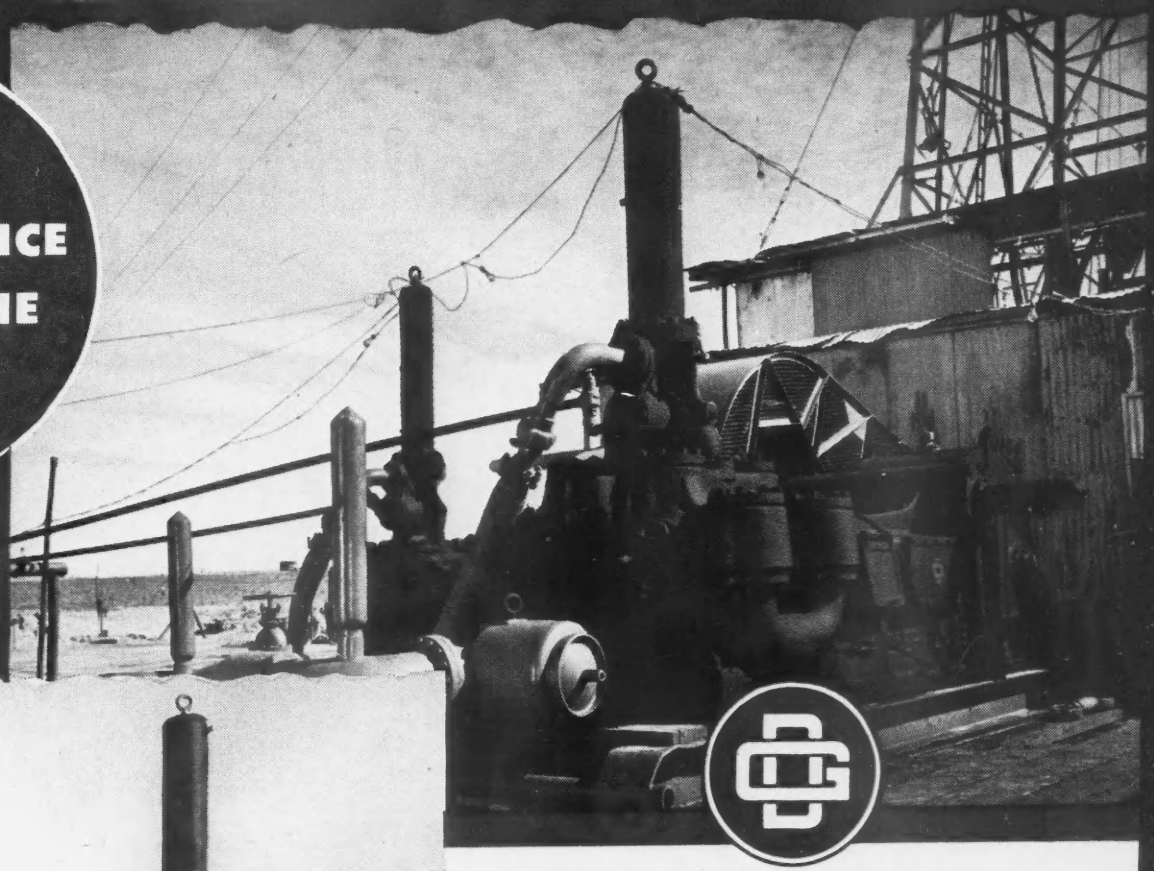

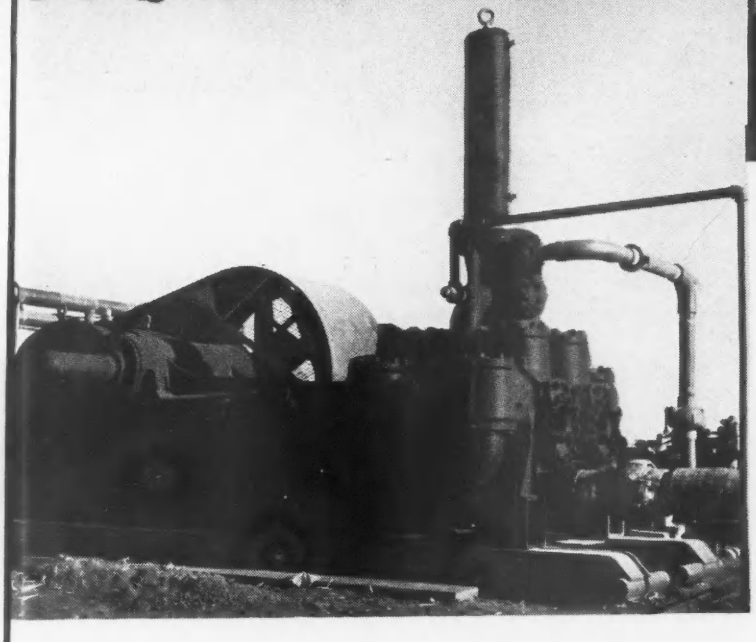

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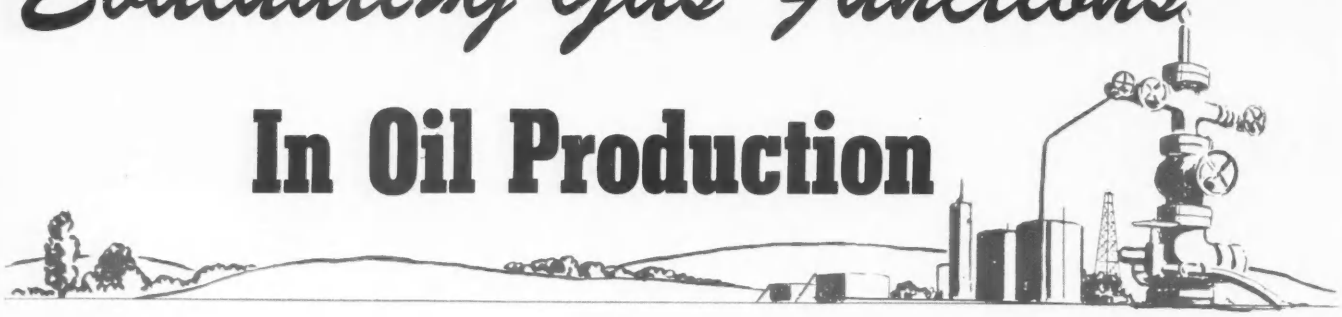
Evaluating Gas Functions In Oil Production



By H. H. KAVELER
Assistant to the Vice President, Phillips Petroleum Company

THE era of science in oil production practice can be dated from 1926 when Beecher and Parkhurst[1] published results of their measurement of the solubility of natural gas in a crude oil at various pressures and temperatures encountered in subsurface reservoirs, along with some measurements of the viscosity and surface tension characteristics of the gas-saturated crude oil. It was the first published effort to make scientific measurements of the physical properties of the mixture that existed in the subsurface reservoir before the natural gas and crude oil were produced to the surface.

After 1926, the oil industry devised the necessary instruments and scientific procedures to measure subsurface reservoir pressure and temperature, the solubility behavior of natural gas in crude oil, the hydrocarbon composition of oil and gas produced, and of oil and gas as it exists in a subsurface reservoir, the permeability and porosity of the rock, the basic principles of the flow behavior of oil, gas and water through reservoir rock, along with other physical and chemical data, all of which comprise what is now generally referred to as "reservoir engineering" information.

The result over the past 20 years has been the development of scientific knowledge concerning events that occur in a crude oil reservoir during the course of time that oil production is obtained. As a result, more oil is recovered from reservoirs than was recovered under the practices common up to the year 1927. The industry has been able to improve its lifting practices. An example is the use of tubing in oil wells to conserve gas as a lifting medium after the oil reaches the well bore. The operation of surface equipment has been improved to the end that greater recovery of oil, as well as gas, is obtained.

Basic Conclusions:

A statement in non-technical terms that summarizes briefly the fundamental technical conclusions concerning the function of gas in the production of crude oil may be given in the following five paragraphs:

1. Crude does not produce itself from subsurface reservoirs. Instead, oil must be expelled from the porous, permeable rock in which it is found into well bores from which it may be removed to the surface of the earth. A source of energy within the reservoir is necessary to the production of crude into well bores. The energy source may be energy stored in gas under pressure and naturally present with the crude. The energy source may be from water under pressure and in permeable contact with the crude in the common source of supply. The source of productive energy may be a combination of gas under pressure and water under pressure within the crude reservoir. Oil pools are classified as "gas drive" or "water drive," depending upon whether or not gas under pressure or water under pressure is the principal source of productive energy. The first step in designing and carrying out conservative operating practices requires that the principal source of energy be identified in order that the pool may be operated in a manner as to conform to the practice that best utilizes the particular major source of energy of production.

This discussion is directed solely to the function of gas in the production of crude. All further statements unless otherwise specifically qualified will refer to the behavior of "gas drive" type reservoirs where gas under pressure is considered to be the only source of the oil productive energy.

If a pool be gas-drive in character, the gas under pressure responsible for the production of oil may exist in the reservoir as a solution component with the crude oil comprising a single phase mixture of oil and gas that is called "reservoir liquid"; or, the gas under pressure may exist as free-gas overlying the oil-saturated section (reservoir liquid saturated section) and occupying the structurally highest points in the common source of supply. Whether the gas under pressure be in solution as a part of the reservoir liquid or whether it be present partly as free-gas in a gas-cap

THE AUTHOR shows how the industry has found that the best practice is to maintain pressure by gas-injection from early in the life of a pool instead of permitting reservoirs to decline to a "secondary recovery" stage before the effort is made to make the maximum use of gas as an oil recovery agent. Repressuring operations have now given way to gas-injection pressure-maintenance wherein gas produced from a pool is returned to the reservoir from early in the life of production. Under such practice, pools do not reach the stage of depletion requiring repressuring. When the modern practice is followed, the result is a substantial increase in the recovery of oil over that which could otherwise be obtained. The paper, somewhat abridged here, was presented to the Regulatory Practices Committee, Interstate Oil Compact Commission, at the recent meeting in Wichita, Kansas.

overlying the oil is a matter also to be considered in designing the operation of the field to accomplish full utilization of the gas-drive energy of production. It is obvious that gas produced directly from gas-caps overlying the oil-saturated section would have no opportunity to expel oil into well bores. Therefore, gas-cap gas produced through "gas wells" would be produced in such a manner as to result in less oil recovery than might be obtained where the gas in a gas-cap overlying oil produced through the oil-bearing section into a lower structure well bore.

If gas under pressure is the energy source for the production of crude oil, then it stands to reason that oil cannot be produced from gas-drive reservoirs without at the same time producing gas. In reservoirs of this type, gas must be produced along with oil to accomplish the production of oil. There is no way to legislate or repeal this circumstance of nature. Compressed gas in an oil reservoir accomplishes the production of oil only by reason of the fact that the pressure maintained at the face of the rock in the well bore is less than the pressure of the gas in the surrounding reservoir. The gas under pressure in the reservoir expands and in its movement through the rock to the point of lower pressure maintained in the well bore expells crude oil from the reservoir into the well bore. Thus, gas must appear along with oil to accomplish the production of oil in gas-drive reservoirs.

The amount of gas that must be produced from a reservoir to obtain a barrel of oil in the well bore depends upon a number of factors. As a general rule, it may be stated that the amount of gas required to produce a barrel of oil increases as the oil saturation of the rock decreases. At the very beginning of production from a completely oil-saturated section of rock, the amount of gas produced with each barrel of oil expelled into the reservoir would be the amount of gas actually in solution with each barrel of crude. This is the so-called "solution" gas-oil ratio. As the rock is depleted of its oil saturation, the amount of gas required to produce a barrel of oil at the same reservoir pressure correspondingly increases. These facts are borne out by actual experience in every gas-drive reservoir. The producing gas-oil ratio is at first low. As production is taken, the gas-oil ratio steadily increases. If the gas energy of the reservoir is not maintained by artificial means, such as the re-injection of the produced gas, the gas-oil ratio ultimately declines again to a low value because the gas supply is depleted. If left to its natural course, the supply of gas is depleted before all the oil that could otherwise be recovered is obtained.

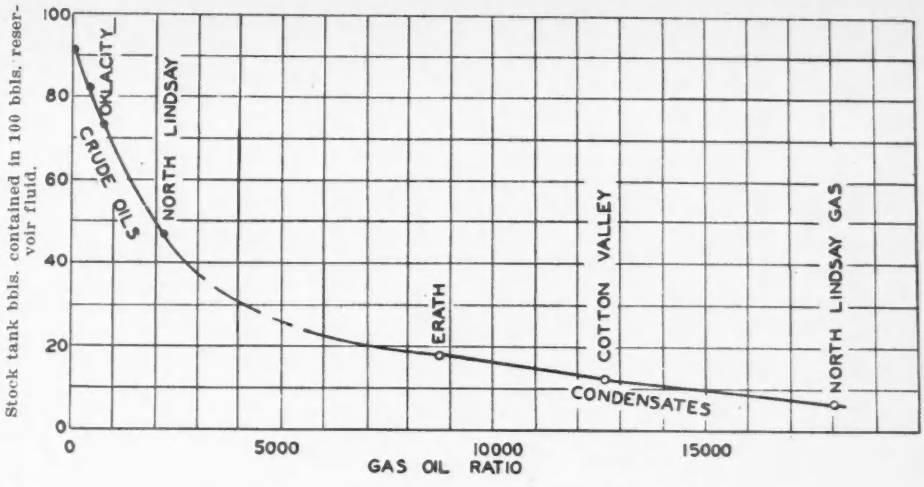


FIGURE 1. Comparison of the gas-oil ratio on surface separation of certain typical reservoir fluids.

A convenient measure of the efficiency with which a gas-drive reservoir is being operated lies in the amount of crude that is recovered per unit of gas produced. Thus, the producing gas-oil ration by one method of operation as compared to another can be utilized to measure the relative efficiency of various methods employed in production. From the standpoint of conservation of the natural resource, the producing gas-oil ratio of the entire common source of supply must be used in arriving at such comparison. It is obvious that one well producing at a higher gas-oil ratio than another in the same reservoir is utilizing reservoir energy less efficiently than the other.

When gas is the source of the energy of production (in the absence of water-drive) it may be said with certainty that economic production of oil will cease when the supply of gas is exhausted or when the pressure of the gas remaining in the reservoir declines to a level where oil is no longer expelled into well bores at economic rates of production. The application of vacuum to reservoirs or the dependence upon gravity drainage of oil into wells in the absence of gas pressure in the reservoir are not in themselves economic means for recovering oil.

Percentage Recovery

The experience of the American industry is definite enough to indicate that gas-drive reservoirs operated in the manner common to the American industry over the past 89 years have yielded only 15 to 35 percent of the crude initially-in-place in a pool. There is a technical basis for saying that the percentage of recovery from gas-drive pools could be substantially increased if practices dictated by a better understanding of the function of gas in the production of oil were more generally adopted.

2. "Solution gas" is, in fact, a liquid component of reservoirs. A fact often difficult to understand if one has not had the opportunity to study the technical background involved is that the common word "liquid" and the common word "gas" are only convenient classifications of substances comprising the fluid state of matter. The fact is that there are only two distinct states of matter, the solid state and the fluid state. Within ordinary human experience, direct observations are confined to conditions of pressure and temperature prevailing at or near the surface of the earth. The atmospheric pressure and temperature are relatively uniform. Human beings are not subjected to pressure variations in the range of 14 pounds per square inch to as high as 5000 pounds per square inch or higher such as natural gas and crude are subjected to in the course of production from a reservoir to the surface of the earth. Within ordinary human experience it is therefore convenient to distinguish between water, described as being a "liquid," and air, described as being a "gas." Under the usual conditions of pressure and temperature prevailing on the surface of the earth the two substances have different properties which may be described as liquid in one instance and gas in another. Thus, one of the ordinary distinctions between water and air is that water weighs about 8.3 pounds to the gallon, while air weighs only .01 pound to the gallon. Yet, a condition of pressure could be imposed upon air whereby it would weigh as much per gallon as does water by the mere fact that gas can be compressed and more and more gas can be confined to a given space as pressure is increased on the gas. The fact is that conditions of pressure and temperature can be imposed upon any gas or upon any liquid such that the distinction between liquid and gas which

is ordinarily attached to the respective classifications would entirely disappear. Thus it is that the words "liquid" and "gas" as applied to crude and natural gas have meaning only in the ordinary sense when the substances occur under conditions of pressure and temperature existing on the surface of the earth. Under conditions of pressure and temperature existing in subsurface reservoirs there may be no distinction between what is ordinarily called "gas" and what is ordinarily called "liquid."

Gas-Crude Mixture

Many examples have been called to the layman's attention of instances where gas may dissolve in liquid. It is common knowledge that air dissolves in water. Carbon dioxide gas is dissolved in water to produce carbonated beverages. In a similar manner, natural gas dissolves in crude when pressure is applied to a mixture of natural gas and crude oil. The important fact at this point, however, is that when gas is dissolved in crude the volume of liquid (in the ordinary sense) in the system increases. As an example in a common case, when one barrel of crude is confined with natural gas at a reservoir pressure of 5000 pounds per square inch at a reservoir temperature of 180° F., then 1000 standard cubic feet of natural gas may go into solution in the one barrel of crude oil, but there will result 1.6 barrels of liquid (reservoir liquid). The dissolved gas actually becomes a liquid component and is as capable of saturating reservoir rock as is the contents of the one barrel of the liquid referred to as crude oil. Among other things, we have come to refer to the fact in this particular instance by stating that this particular reservoir liquid has a reservoir volume factor of 1.6. That is to say it takes 1.6 barrels of liquid existing in the reservoir to produce a barrel of crude oil (that is, stock tank oil which is sold to pipe lines). On production one barrel appears as a liquid in the stock tank and 0.6 of a barrel appears as natural gas on the surface of the earth, although the entire quantity in the reservoir was actually more nearly liquid in the ordinary sense of the word "liquid."

Thus it is that surface appearance as liquid and gas bears no relation to the actual subsurface appearance where both the 1000 cubic feet of gas and the one barrel of stock tank oil existed as a fluid more nearly like ordinary liquid in character.

The fact that gas dissolved in oil in a reservoir actually exists in the liquid state in the ordinary sense of the word "liquid" has a number of significant implications. So long as the pressure of gas is maintained in a reservoir, the liquid saturation in the porous rock is maintained at a higher value due to gas in solution. The efficiency with which gas can expel liquid from the reservoir rock is, therefore, greater by virtue of the greater liquid saturation alone. There is the additional fact that gas in the ordinary sense is more "fluid" than is liquid. That is to say that gas will flow more readily. Gas dissolved in oil, therefore, lowers the viscosity of the oil and as a result, reservoir liquid flows more readily to well bores than does crude itself. For these and other reasons, reservoir liquid comprising crude oil plus its solution component of natural gas is more recoverable than is crude itself. One may make an alternative statement to the effect that under conditions where reservoir pressure is maintained at or near its maximum limit in gas-drive reservoirs, the fluid properties of the reservoir liquid may be maintained at optimum values and the recovery of crude oil correspondingly increased.

Ordinary natural gas under conditions of high pressure and temperature may be the "solvent" component in reservoirs. It is often difficult to state which component is acting as the solvent for the other. This is particularly true in systems like crude and natural gas where, following the discussion of the preceding paragraph, conditions of high pressure may arise where gas is so highly compressed that it may, in fact, take on the appearance of having properties that are ordinarily called liquid properties, and may then act as a "solvent."

The producing characteristics of many fields referred to as "distillate" or "condensate" immediately suggested that natural gas under certain conditions of pressure and temperature was capable of dissolving and holding components of crude oil that were ordinarily liquid. Thus, fields are becoming more common wherein the stock tank oil recovered is higher than 50 API gravity and is colorless, or nearly colorless, in appearance where the liquid is produced at relatively low gas-oil ratios in the order of 5000 to 20,000 cubic feet per barrel. These are producing gas-oil ratios that were commonly associated with the production of colored, less than 50 gravity crude. The nearly colorless, high-gravity stock tank liquid from such fields suggested that the material recovered was to be likened to the material distilled from crude oil in an ordinary refining operation. From this, the production was, at first, called distillate production, and later when it was realized that such reservoirs were, in fact, gas reservoirs where the conditions of pressure and temperature were such that gas could hold ordinarily liquid components in "gaseous solution" the fields were more correctly named "condensate" fields, since the liquid was recovered by condensation through reduction of the pressure and temperature from those existing in the reservoir to those lower pressures and temperatures existing at the surface of the earth.

These remarks may be carried further

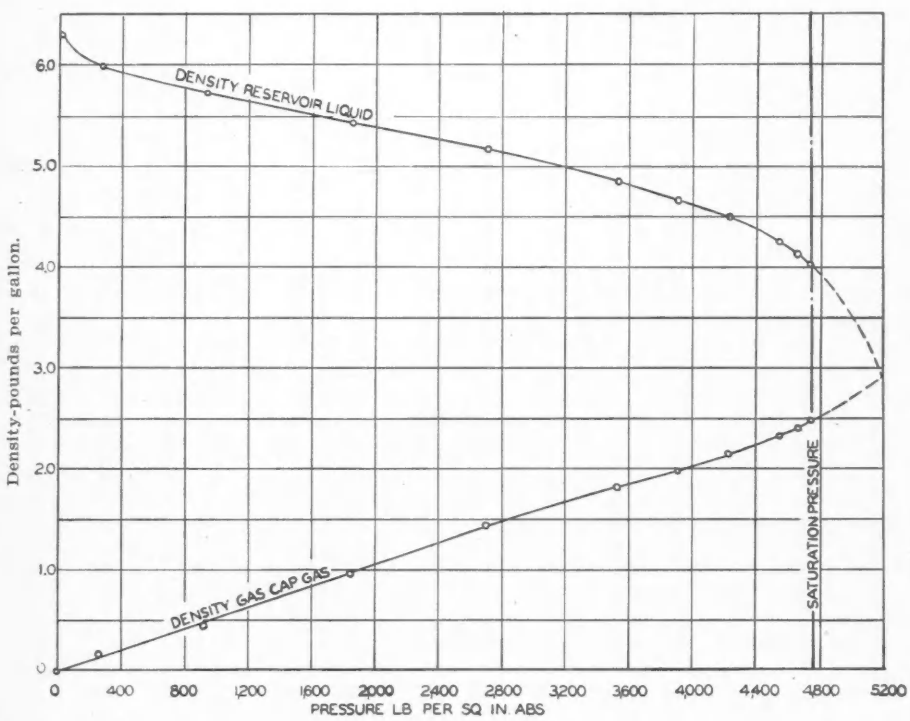
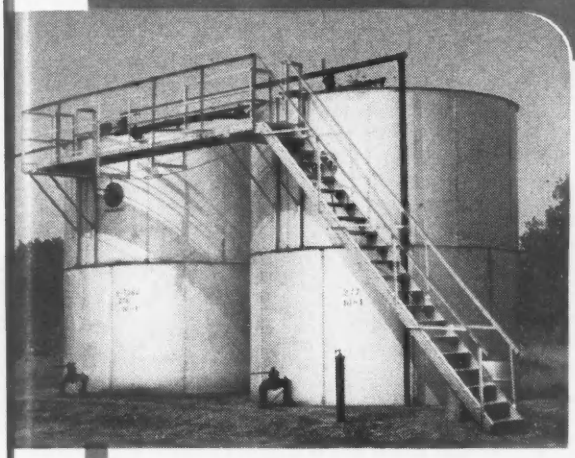
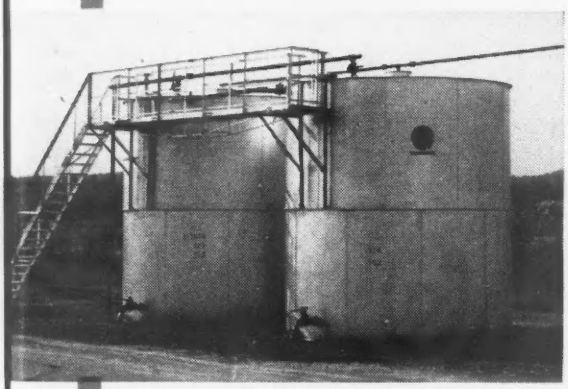
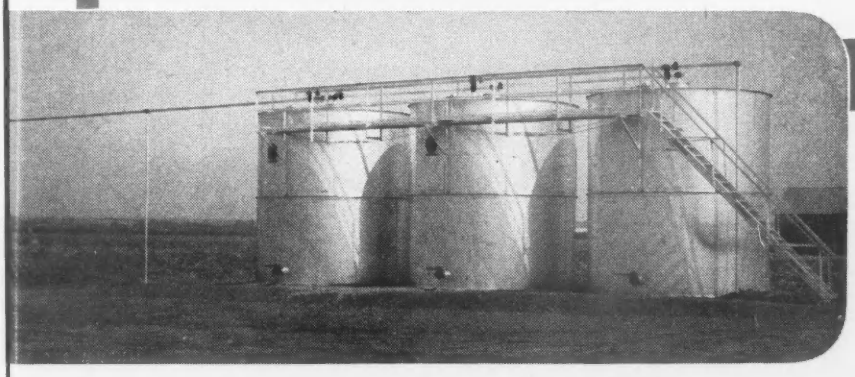


FIGURE 2. Comparative density of reservoir liquid and reservoir gas in a deep pool. Reservoir temperature, 185° F.

M.C. Out Front







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from a purely technical point of view by stating that for each system comprising what is ordinarily called natural gas as one component and what is ordinarily called crude oil as the other component there exists a pressure and temperature where the natural gas is so highly compressed and so capable of carrying liquid in solution, and where the associated crude oil has so much gas dissolved in it that a "critical point" of pressure and temperature may be reached for the system where the ordinary gas and liquid are completely indistinguishable. Since the "critical point" is unique for any given system, few reservoirs are found precisely at that unique condition of pressure and temperature but many reservoirs are found existing at very near the critical point, where even though the producing gas-oil ratio is relatively low, the liquid is colored and comes within the catgory commonly called crude oil, the reservoir is, in fact, to be treated from a viewpoint of the most conservative production practice more like an ordinary gas reservoir than like an ordinary liquid-bearing crude oil reservoir.

Reservoir Comparison

In Figure 2 some typical examples of ordinary crude reservoirs producing at gas-oil ratios of 1000 or less are compared to some typical condensate reservoirs producing at gas-oil ratios as high as 20,000/1 on the basis of the number of stock tank barrels contained in 100 barrels of reservoir space. It is obvious that it would be difficult to draw a line of demarcation between pools representative of crude production, such as Oklahoma City, and pools representative of condensate production, such as Erath or Cotton Valley. Where does the oil field classification stop and the gas field classification begin? If the determining test were producing gas-oil ratio there would be no definite point of demarcation between what is ordinarily called an oil field as distinguished from what is ordinarily called a gas field.

To further illustrate this point, there are represented in Figure 2 the density data for a crude reservoir liquid and its associated gas-cap gas in equilibrium with the reservoir liquid. In the particular pool, the saturation pressure of the reservoir liquid was approximately 4740 pound per square inch absolute at the reservoir temperature of 185° F. Had sufficient gas been present in the reservoir to supply as much gas as would have gone into solution at the reservoir pressure, which was 5200 pounds per square inch (approximately), it is evident that the reservoir liquid existing at 5200 pounds per square inch and the reservoir gas would have approached the same value of density and, on the basis of that property, would have removed any distinguishing feature between gas and oil in the reservoir. The reservoir volume factor for the crude at 5200 pounds per square inch would have been approximately four. This illustrates how little difference there may be in the properties of what is ordinarily called "liquid" and what is ordinarily called "gas" when the gas and liquid exist together in a reservoir. In the sense of operating this particular pool in the most conservative manner, even though crude oil, as ordinarily defined, was recovered in stock tanks the pool should have been produced more in terms of a gas condensate pool than in terms of an ordinary oil pool.

It is apparent, therefore, that a measure of the degree of conservation achieved in the operation of any reservoir must grow out of a measurement of and an understanding of the nature of the oil and gas as they exist together within the reservoir itself. Appearances of the production as production is obtained at the surface are often grossly misleading.

4. The structure of a reservoir is an important factor in the efficient utilization of gas as the energy of production. It is probably well known that the rock constituting the petroleum reservoir almost always lies in the earth in such a manner as to have a structural attitude. That is to say that there is a difference in elevation between segments of the common source of supply. Thus it is that if not from the beginning, then at some time during the course of depletion of pressure in a gas-drive reservoir, there may be a separation of the normally gaseous components and the normally liquid components remaining in the reservoir. This is a result of the gravitational segregation of the ordinarily gaseous components which occupy the structurally higher levels in a common source of supply from the heavier normally liquid components which have a tendency to gravitate to the structurally lower parts of the reservoir. Hence, pools are often discovered with gas-caps initially present, or gas-caps may be induced as a result of the production of petroleum. In either event during the life of any pool the structurally higher segments of the pool are productive of the greater volume of gas per barrel of crude oil produced. This is quite evident from experience in actual operations. Efficient utilization of gas as a productive force dictates an operation of any common source of supply which causes a general movement of the reservoir fluids down-structure so as to maintain, insofar as practical, a liquid seal between the wells producing at the lower structural level and the upper level of the reservoir which will in the ordinary course of events become predominantly gas-bearing. The old theory of maintaining a "liquid seal" in the well bore at the face of the sand by spacing of tubing or the submergence of pumps, which was popular over many years in the industry, gave expression to the principle here involved, although the fact is that the only effective liquid seal is one that can be maintained within the reservoir rock itself. If gas-oil ratios of producing wells cannot be controlled by operations inside of the reservoir, there is little, if any, hope of maintaining minimum gas-oil ratios by manipulation of equipment in the well bore.

5. The principles of gas-drive recovery are the same whether the gas be native to the formation or injected into it. Gas under pressure in a reservoir is a storehouse of energy available to the production of oil. The techniques involved in the recovery of crude oil by gas under pressure are no different as between gas native to the formation and gas injected into the formation. From a basic technical point of view, repressuring, pressure-maintenance, and the control of producing gas-oil ratio are all essentially one and the same operation in that each seeks to maintain reservoir gas pressure. The only fundamental difference among any of the three operations lies in the efficiency that may be achieved in the oil recovery process. In consideration of the fact that as much gas should be maintained in solution in the oil as may be possible at all times for the purpose of maintaining optimum liquid conditions of the oil in the reservoir, pressure-maintenance operations by the return of all produced gas from the beginning of oil production is the most economic and most efficient way to produce a gas-drive common source of supply. It is the type of operation which leads to the greatest conservation of both the oil and the gas resource. It is often possible to utilize injected gas when the reservoir pressure is maintained at a high level to produce more oil than could be attributed to the gas initially present.

A Conclusion

Efficient operation of gas-drive pools is no longer primarily a technical problem. If the question of efficient operation involves, from the viewpoint of conservation of both oil and gas, recovering twice to three times as much oil per acre-foot of initially saturated reservoir rock as has been obtained from such pools in the ordinary past course of events, then it may be said that the technologists of the industry, based upon the scientific research of the industry, stand ready to do that.

Any production operation that is designed from an understanding of the

■ CONTINUED ON PAGE 182

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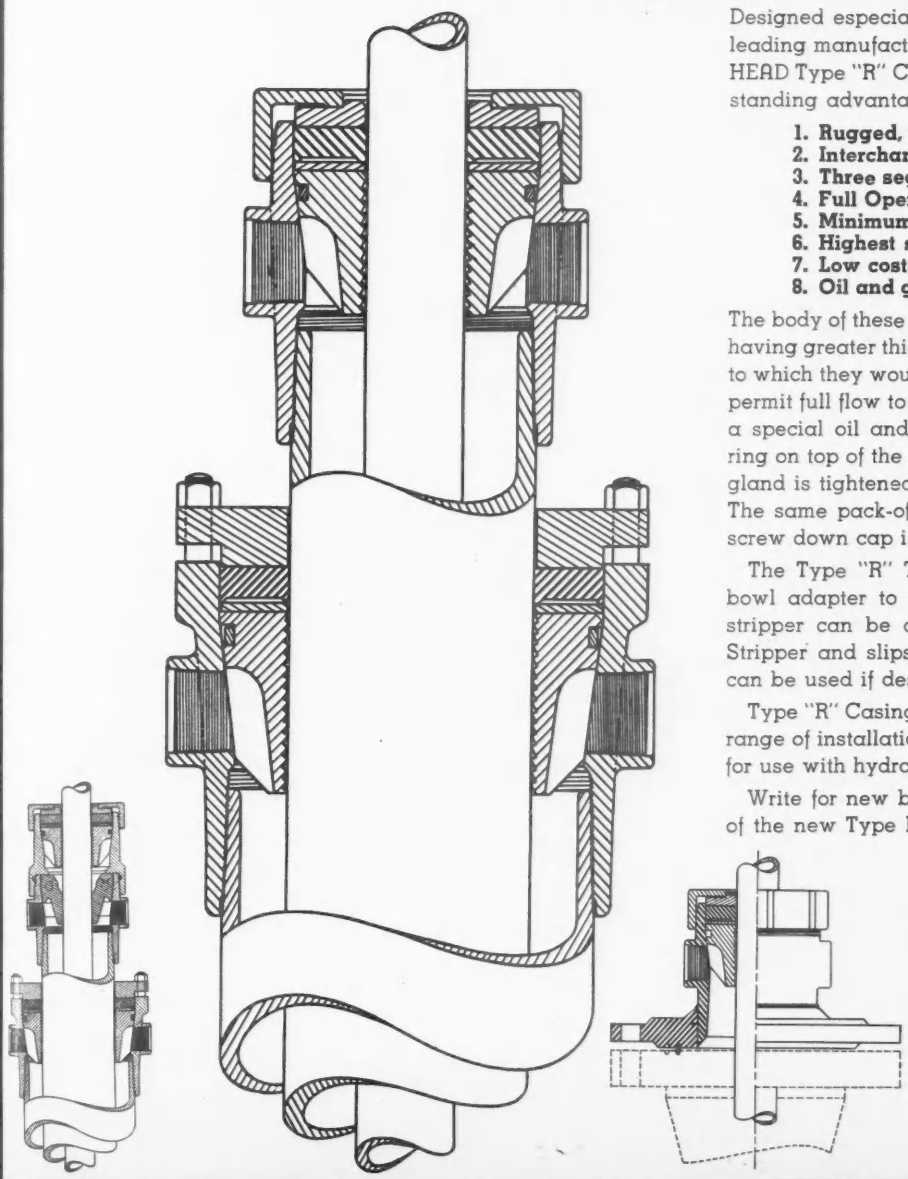

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Oil Production by Gas and Flooding

Part 10—(CONCLUSION)

WATER REQUIREMENTS FOR FLOODING

INJECTION of water at a declined reservoir pressure may be classified under flooding and circulating water. Flooding requires 3-6 barrels of injected water per barrel of ultimate oil recovery; whereas, 10-20 barrels of water may have to be injected per barrel of ultimate oil recovery by circulating water. A reservoir may be produced as one, two or possibly three flooding units. In producing oil by circulating water, a reservoir is split up into a comparatively large number of units. Investment and operating expenses are less for flooding. A greater ultimate oil recovery can be achieved by flooding than by circulating water. Flooding usually requires unitization.

Produced Water

Let Q_o be the oil producing rate and Q_w, the water producing rate. Then, by equation (10) of part 9,

$$\frac{Q_o}{Q_o + Q_w} = X = \left(\frac{1-C}{1-D}\right)^2$$

and the ratio of water to oil in production is given by

$$\frac{Q_w}{Q_o} = \frac{1-X}{X} = \left(\frac{1-D}{1-C}\right)^2 - 1$$

Let W represent barrels of produced water per barrel of cumulative oil recovery. Then

$$W = \int\left[\left(\frac{1-D}{1-C}\right)^2 - 1\right] dC$$

which gives

$$W = \frac{(C-D)^2}{1-C} \qquad (1)$$

Solutions of equation (1) are shown in Figure 10-1. A million barrels of produced water, from a unit that contained a million barrels of oil displaceable by flooding, is likely to achieve the following oil recovery:

Breakthrough	Zero	20	40
Million barrels of oil	0.62	0.73	0.82

The cumulative oil recovery at any time will now be indicated for a uniform rate of water injection. The fill at any time is yQ_i aside from migrated and produced water. By equation (5) of part 9,

$$yQ_i = F = \frac{(3-2g)\,C + 2g}{3} \qquad (2)$$

The produced water, by equation (1), is $(C-D)^2/(1-C)$ barrels per barrel of cumulative oil recovery. But injected water yQ_i is in terms of fill. Let E equal fill in terms of produced water. Thus

$$E = \frac{(C-D)^2}{1-C} \cdot \frac{1-g}{b} \qquad (3)$$

and

$$yQ_i = \frac{(3-2g)\,C + 2g}{3} + \frac{(1-g)\,(C-D)^2}{b\,(1-C)} \qquad (4)$$

where oil production is neglected until

$$y = \frac{2g}{3Q_i}$$

and water is not produced until oil recovery C is greater than the breakthrough oil recovery D.

The data in Figure 10-2 are solutions of equation (4) for the following conditions:
Free gas = 30 percent of fill
Volume factor = 1.1 barrels per barrel oil
Breakthrough, D = O.

The rate of water injection averages 20 percent per year of fill after migrated water. The C curve shows cumulative oil recovery in percent of displaceable oil. The area on the left side of the C curve is proportional to the sum of retained and produced water.

The rate of oil production averages 19.3 percent of displaceable oil during the second year. The oil producing rate was obtained by differentiating equation (4). Between the eighth and ninth years, the oil producing rate averages 3.4 percent per year. Over nine years of water injection at the average rate of 20 percent per year are required in order to recover 70 percent of displaceable oil. The area under the dashed portion of the oil rate curve suggests the influence of neglecting the oil recovered during the waiting period.

Declining Rate of Water Injection

The rate of filling a flooding unit varies with the rate of drilling injection wells, the rate of injection relative to injection capacity of the wells already drilled and the rate of producing water. Therefore, the rate of oil recovery immediately after a 2g/3 fill may be increasing, uniform or declining.

In the example of Figure 10-2, the rate of water injection was uniform. But the rate of oil recovery started declining at 2g/3 fill by virtue of zero breakthrough. The uniform rate of water injection could have been maintained either by drilling additional injection wells subsequent to 2g/3 or by drilling a sufficient number of injection wells initially and not operating them at capacity. In the field, the rate of oil recovery may decline by virtue of a declining rate of water injection and produced water.

The fill at any time for a declining water injection rate is given by

$$\int Q_i dy = A\,(1 - e^{-Ry/A}) \qquad (5)$$

where A is some constant, R is the injection capacity and y is time reckoned from a date for which the injected water during a period of development divided by time gives the injection rate R. The value of y that makes the right side of equation (5) equal to the right side of equation (4) gives the number of years required in order to accumulate a fraction C of displaceable oil with a declining rate of water injection and produced water.

As an example, let the values of b, D

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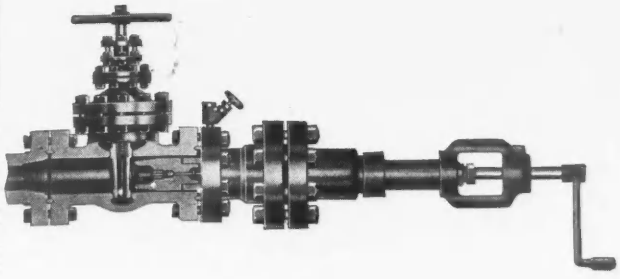

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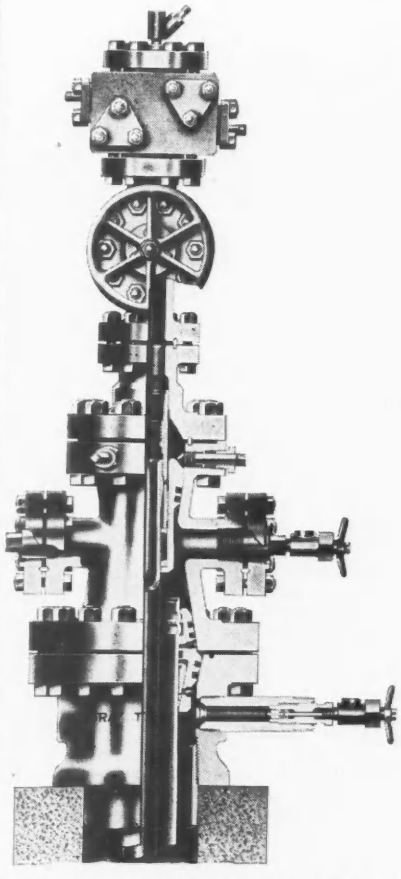

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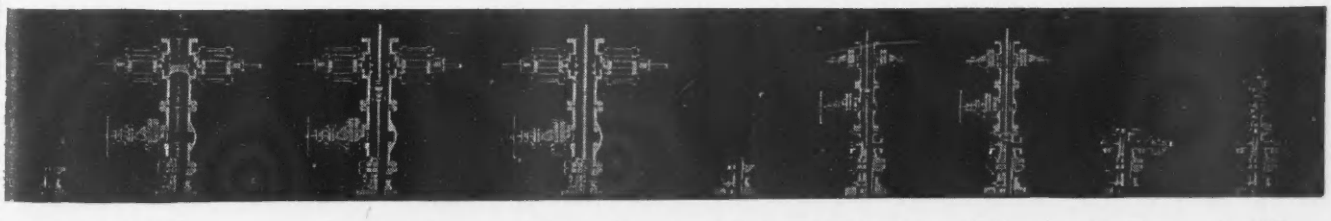

Casing Head Attached | Drilling | Running Casing | Casing Landed | Drilling Control Equipment Removed | Drilling-in and Running Tubing | Tubing Landed | Control Equipment Removed | Manifold Attached

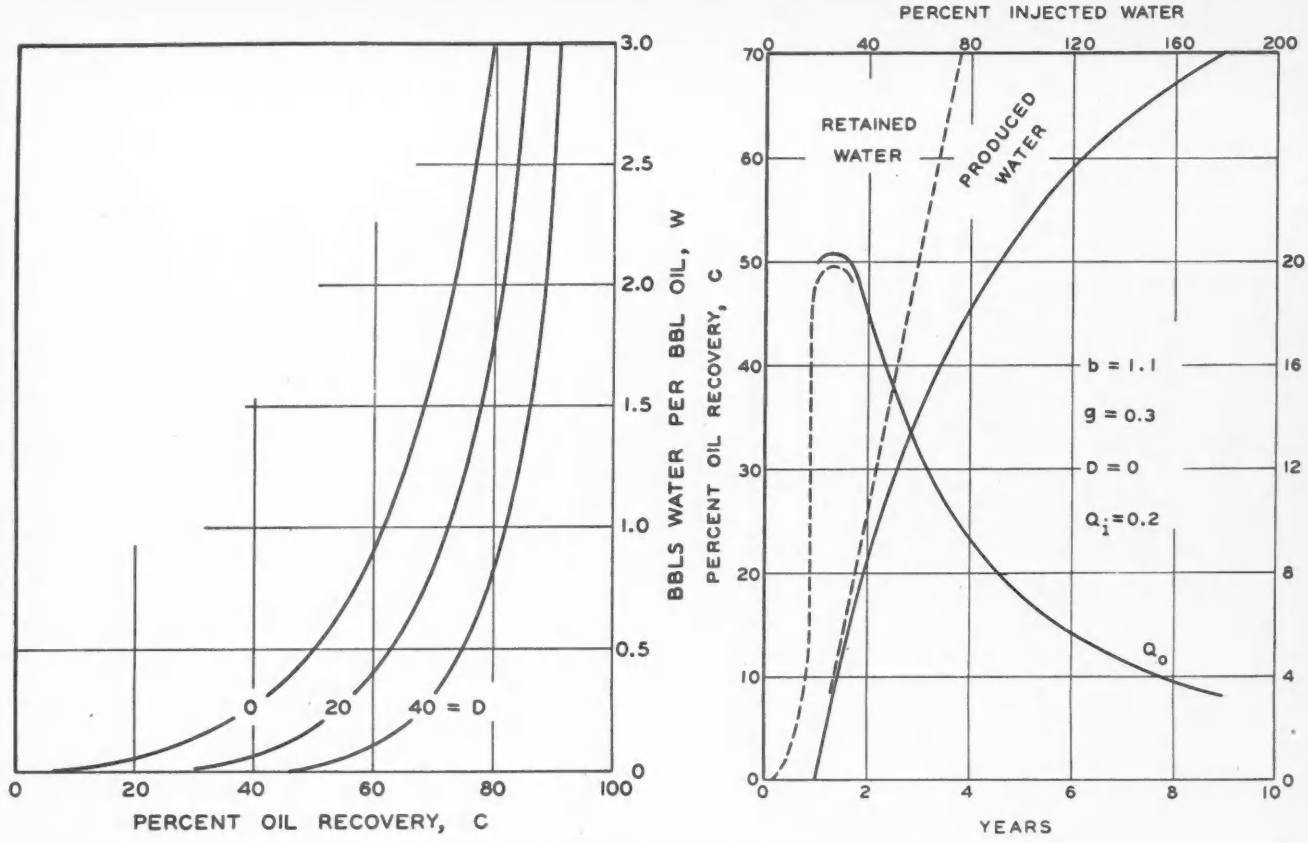

FIGURE 10-1 (left). Produced water in barrels per barrel of cumulative oil vs. oil recovery and breakthrough D.
FIGURE 10-2 (right). Estimated oil recovery C and annual oil producing rate Q_o for a 20 percent per year uniform rate of fill and zero breakthroug

and g be the same as those in Figure 10-2. Then the injected water W_i required in order to achieve a recovery C is given by

$$W_i = 0.2 + 0.8C + 0.636\frac{C^2}{1-C}$$

Let the plugging constant A equal unity and the peak rate of injection R be 40 percent per year of fill. Then the injected water is given by

$$W_i = 1 - e^{-0.4y}$$

Figure 10-3 is a solution of the foregoing expressions. Cumulative water injection W_i, retained water F and Produced water W are plotted against time in years. Curve C shows the cumulative oil recovery in percent of displaceable oil. The waiting period is seven months. About nine years would be required in order to recover 52 percent of displaceable oil. The same data are plotted against injected water in Figure 10-4.

The Annual Rate

Differentiate equation (4) and obtain

$$\frac{Q_o}{Q_i} = \left[\frac{3-2g}{3} + \frac{1-g}{b} \cdot \frac{(C-D)(2-D-C)}{(1-C)^2}\right]^{-1} \quad (6)$$

where Q_o/Q_i is the ratio of oil producing rate to the rate of fill. The second term within the brackets is zero prior to breakthrough. The first term is zero during the waiting period.

When the rate of water injection is not uniform,

$$Q_i = Re^{-Ry/A} \quad (7)$$

Both of the foregoing equations are on the basis of not including for the waiting period the oil that actually would be accumulated during that period. Note also that the injected water for which oil recovery is C and time is y gives the connection between Q_i and Q_o.

For the conditions in Figure 10-3,

$$\frac{Q_o}{Q_i} = \left[0.8 + 0.636\frac{C(2-C)}{(1-C)^2}\right]^{-1}$$

and

$$Q_i = 0.4e^{-0.4y}$$

Solutions of the foregoing expressions are shown in Figure 10-5. The rate of oil recovery declines to about 1 percent per year of displaceable oil during the 7th year of water injection. The corresponding cumulative oil is about 50 percent. In the field, however, the economic limit as to oil producing rate may be greater than one percent per year. The reserve could be less than 50 percent. The economic limit as to oil producing rate is another reason for providing ample injection capacity.

Total Injection Requirements

Operating expenses vary with dry oil reserve and ultimate oil recovery. For example, relative to an 80 percent cut at economic limit, the ultimate oil recovery would be 55 percent for a zero breakthrough and 82 percent for a (percent breakthrough. In this compar son, the operating expenses for the percent ultimate recovery are sever times the operating expenses for the (percent dry oil recovery. The differen is caused by the location of injectio wells and is reflected in the total i jection requirements.

Total injection requirements inclu migrated, retained and produced wate Migrated water, in the downdip dire tion from a row of injection wel located near an oil-water contact, is n included in the total water requiremen herein considered.

Let unity equal the total fill require in order to ultimately recover 100 pe cent of displaceable oil. Then the i jection requirement W_r in barrels retained water per barrel of recovere oil is given approximately by

$$W_r = \frac{g + bC}{C} \quad (8$$

where g is the fraction of total fi occupied by free gas at the outset flooding, b is the volume factor for o and C is cumulative oil recovery e pressed as a fraction of displaceable o Thus, when free gas is 34 percent total fill and the volume factor is 1 barrels per barrel of oil, a millio barrels of recovered oil would requi 1.44 million barrels of retained wat when the recovered oil is 100 percen and 1.78 million barrels when the re

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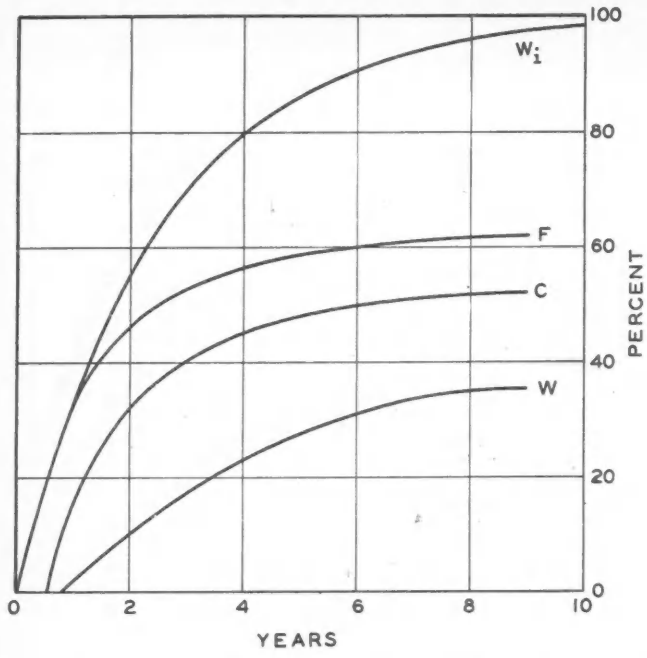

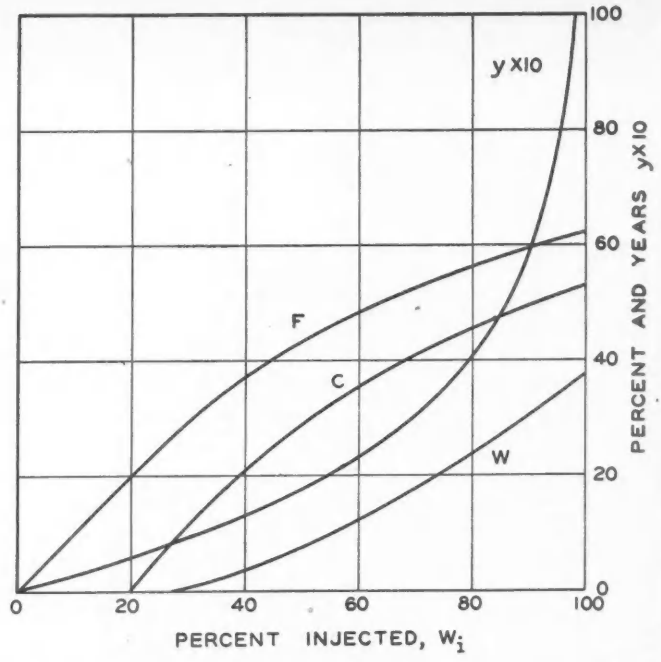

FIGURE 10-3 (left). A declining rate of water injection gives the injected water W_i of which F is retained and W is produced; the corresponding oil recovery is C percent of displaceable oil; injected, retained and produced water are in percent of fill.
FIGURE 10-4 (right). Cumulative oil recovery C, fill F, produced water W and years y vs. injected water for the conditions in Figure 10-3.

covered oil is only 50 percent of displaceable oil. The 1.78 barrels of water per barrel of recovered oil is aside from a nominal correction for non-displacement of some free gas and the invaded acre-feet equal the acre-feet to be invaded.

The injection requirement for produced water is defined approximately by equation (1). The total injection requirement W_t in barrels of water per barrel of recovered oil is given approximately by

$$W_t = \frac{g + bC}{C} + \frac{(C - D)^2}{1 - C} \qquad (9)$$

where D is dry oil recovery and (C — D) is wet oil recovery.

In terms of X the fraction of oil in production for unit invasion

$$\frac{(C - D)^2}{1 - C} = \frac{(C - D)^2}{(1 - D)X^{1/2}} \qquad (10)$$

For 10 percent oil in production at economic limit, cumulative oil recovery is 68 or 87 percent for a zero or a 60 percent breakthrough. Produced water would be

$$\frac{(0.68)^2}{(0.1)^{1/2}} = 1.46$$

or

$$\frac{(.17)^2}{0.4\,(0.1)^{1/2}} = 0.23$$

barrels per barrel of recovered oil. The ratio of produced water is 6.3 in this example. But the ratio of total operating expenses would be more than 6.3 because of combined injection and production expenses. In addition, the investment per barrel of ultimate oil recovery would be higher for the zero breakthrough because of the comparatively smaller reserve.

Injection Capacity

Let there be N wells on an injection row. The average per-well injection capacity q is defined by

$$q = \frac{3.07hIK\Delta P}{\mu \log \frac{2d}{r}} \qquad 11$$

where

- d = average distance from injection row to the last row of producing wells, feet
- h = average completion for N injection wells, feet
- I = interference factor for N wells
- K = average effective permeability to water for a flooding-well-row system, darcys
- $\Delta P = P_b - P_r$ = average buildup for N injection wells, pounds per square inch
- P_r = reservoir pressure, psi
- P_b = operating bottom-hole injection pressure, psi
- μ = viscosity of water, centipoises
- r = radius of well bore, feet
- q = barrels per day per well

log is to base ten.

The interference factor I between the injection wells on one row is about 0.64. The value of log 2d/r for six-inch well bores ranges from 3.9 for d = 1000 to 4.8 for d = 5000 feet.

The effective permeability of an injection system decreases during the life of a flooding project by virtue of plugging in the vicinity of injection wells. Hydration of bentonite and of other hydratable fines in pay also reduces the effective permeability to water. Provisions for an ultimate fivefold decrease in effective permeability is not unreasonable. A flooding prospect that cannot yield a reasonable rate of return on investment relative to a prospective fivefold decline of injection capacity is a marginal prospect.

The number of years required to inject a given volume of water when the rate of injection declines from an initial to one-fifth of the initial rate is about 2.5 times the number of years required for injecting the same volume at a uniform rate equal to the initial rate. Hence, the average effective permeability is about 40 percent of the initial value.

The maximum bottom-hole injection pressure is about D psi where D is depth to pay in feet. Upon substituting 0.64 for I, 1.0 for water viscosity, dividing by 2.5 for average plugging, 4.0 for log 2d/r and D for P_b, equation (11) gives

$$\frac{q_a}{h} = 0.2K\,(D - P_r) \qquad (12)$$

where q_a/h is the daily average rate of water injection to be expected per foot of completion when the reservoir pressure is P_r. The initial expectancy is 2.5 times the average or 0.5 barrels per day per foot per darcy per pound pressure difference. Hence, with plugging, there is a big spread between the initial and ultimate well requirements for a given rate of water injection.

Depth vs. Injection Capacity

In order to illustrate the influence of depth on average intake expectancy, let reservoir pressure be 200 psi and permeability 200 millidarcys irrespective of

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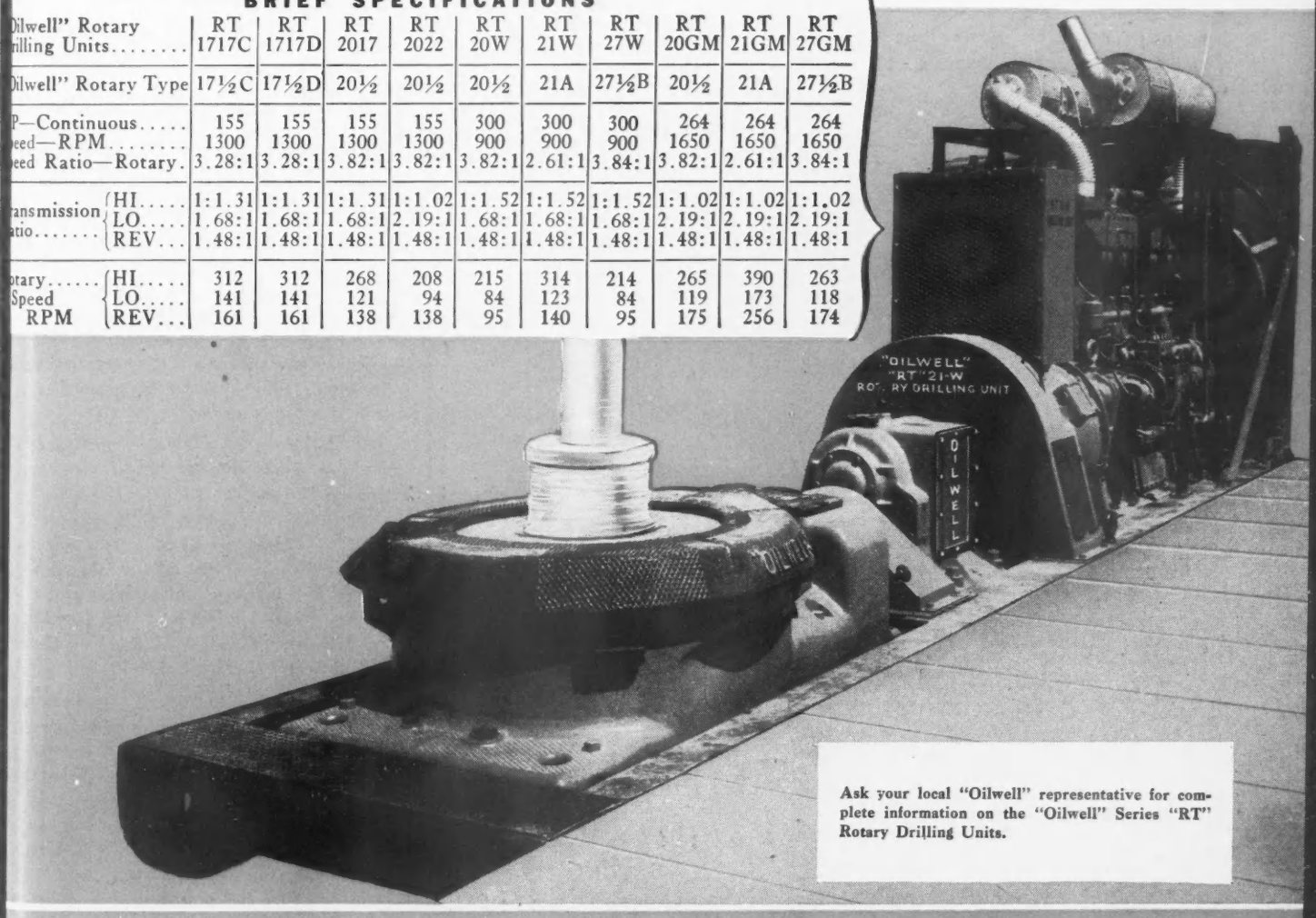
HP—Continuous	155	155	155	155	300	300	300	264	264	264
Speed—RPM	1300	1300	1300	1300	900	900	900	1650	1650	1650
Speed Ratio—Rotary	3.28:1	3.28:1	3.82:1	3.82:1	3.82:1	2.61:1	3.84:1	3.82:1	2.61:1	3.84:1
Transmission Ratio HI	1:1.31	1:1.31	1:1.31	1:1.02	1:1.52	1:1.52	1:1.52	1:1.02	1:1.02	1:1.02
Transmission Ratio LO	1.68:1	1.68:1	1.68:1	2.19:1	1.68:1	1.68:1	1.68:1	2.19:1	2.19:1	2.19:1
Transmission Ratio REV	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1	1.48:1
Rotary Speed RPM HI	312	312	268	208	215	314	214	265	390	263
Rotary Speed RPM LO	141	141	121	94	84	123	84	119	173	118
Rotary Speed RPM REV	161	161	138	138	95	140	95	175	256	174



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depth. The comparative data would be as follows:

Depth, feet	500	1000	2000	4000
Pressure difference, psi	300	800	1800	3800
Barrels per day per foot	12	32	72	152
Depth ratio	1	2	4	8
Intake ratio	1.0	2.7	6.0	12.7
Injection pressure, psi	300	600	1200	2400

The advantage with depth for intake ratio tends to be offset by the cost of drilling deeper wells, higher injection pressure and greater oil and water lifting cost.

Flooding vs. Circulating Water

A distinction is made between flooding and circulating water. Flooding requires 3-6 barrels of water per barrel of ultimate oil recovery. Whereas, in producing oil by circulating water, 10-20 barrels of injected water is required per barrel of ultimate oil recovery. The fill may be substantially less than unity at the time an economic limit as to water in production is reached for circulating water. Hence, oil production by circulating water is not considered here.

Relative Well-Feet

Most reservoirs to be converted into flooding projects have a uniform, staggered or random spacing of producing wells. The wells can be projected onto a reasonable number of strikes. The average elevation of the tops and bottoms for the wells projected onto a given strike may be shown diagrammatically in one dip section. A dip section may also be prepared to show the relative well-feet of completion for producing and injection rows.

Figure 10-6 illustrates the relative well-feet of completion for a linear reservoir having an erosional unconformity at the updip productive limit. Strike distance on linear reservoirs is approximately uniform. Hence the relative well-feet of completion is approximately uniform aside from variable pay thickness and the number of wells on a given strike. The dashed portion of Figure 10-6 refers to a greater number of wells on the initial injection row than on a producing row.

Suppose an oil-water interface has advanced to some average elevation such as B. The region completely flooded out is on the downdip side of some average level such as M. Wells in the M region produce oily water and may be converted to injection wells. Wells in the B-M region produce oil and water and may be shut in.

The dip distance between the B and M levels is on the order of 1000C where C is convergence. However, if some injection wells are overloaded areally, there may be a significant dip for both the B and M levels across a reservoir. On the other hand, when per-interval injection rate is not controlled, some injection wells may be overloaded vertically. In such cases, the B-M distance for the two intervals which have the fastest and slowest rates of depletion respectively may be greater than 1000C.

When the number of injection wells on an injection row is insufficient to achieve unit invasion relative to a B level, some displaceable oil may be by-passed areally. By-passing represents a loss in ultimate oil recovery over and above any oil lost by structural and stratigraphic trapping.

At the time an oil-water interface is at some level such as B, oil will have displaced most of the free gas up to some level such as G. Wells completed in a B-G region produce dry oil by water. Wells completed on the updip side of a G level produce oil by gas, the produced gas having been displaced by oil. The position of a G level is about 1000 C feet from its B level.

Figure 10-7 illustrates the relative well-feet of completion for a radial reservoir. Strike distance on a radial reservoir is proportional to the distance from the center of such reservoirs. Hence, the relative well-feet of completion increases in the downdip direction. The last row on a radial reservoir has only one well and the well-feet of completion in a central well is relatively nominal. The dashed portion of Figure 10-7 refers to a number of wells on the initial injection

■ CONTINUED ON PAGE 182

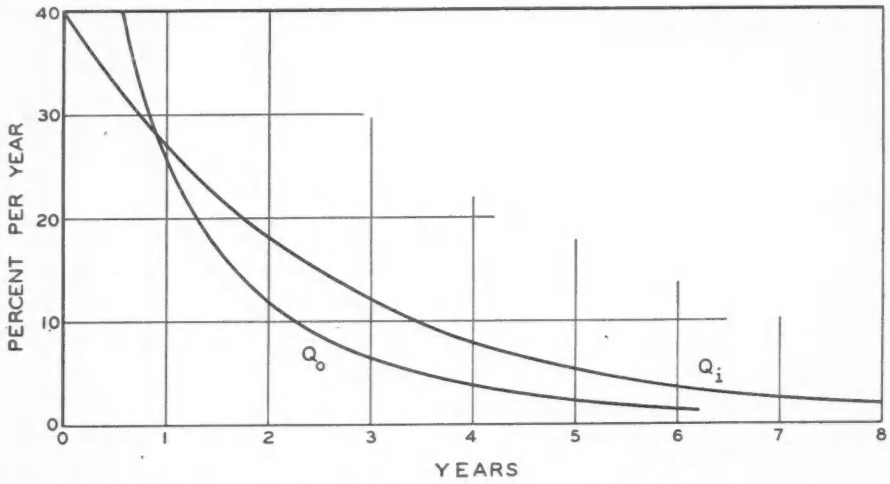

FIGURE 10-5. Rate of water injection Q_i and rate of oil production Q_o for the conditions of Figure 10-3.

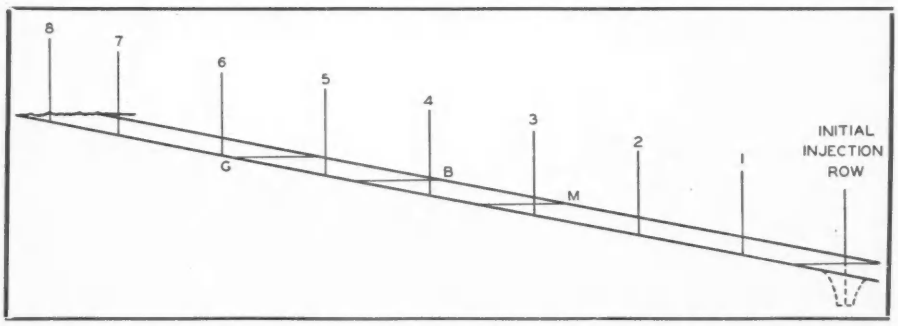

FIGURE 10-6. Relative well-feet of completion for a linear reservoir; region above G, gas and oil; G-B region, oil; B-M region, oil and water; region below M, completely flooded out; relative number of injection wells along initial injection row determines the relative well-feet of completion for injection wells.

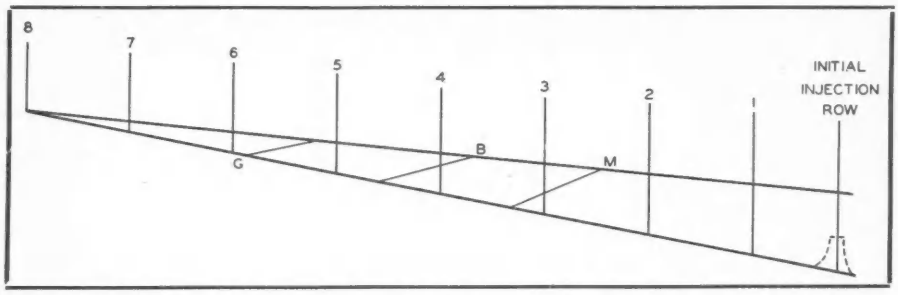

FIGURE 10-7. Relative well-feet of completion for a radial reservoir; symbols G, B and M have the same significance as in Figure 10-6.

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Field and Laboratory Tests of

Sodium Chromates and Alkalies

for Controlling Corrosion in Gas Condensate Wells

Part 2—(OF SIX PARTS)

THEORETICAL CONSIDERATIONS

By

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THE carbon dioxide in a gas-condensate fluid not only contributes to its corrosiveness but determines to a considerable extent what can be done with neutralizing agents and other treating materials to combat corrosion. A knowledge of the solubility of carbon dioxide in water is helpful in planning treatments for preventing corrosion and in predicting what fluids may be corrosive on the basis of their carbon dioxide content.

Shock[7] has proposed that the degree to which wells are corrosive can be determined from the pH of the flowing water or from the computed partial pressure of carbon dioxide in the flowing vapor phase. However, the pH of a solution of carbon dioxide in well water may differ considerably from the pH of a solution of the same concentration of carbon dioxide in distilled water because of dissolved salts and substances other than carbon dioxide that may be present in well water. Also, the extent to which carbon dioxide contained in a natural gas dissolves in well water probably does not depend solely on the temperature and partial pressure of the carbon dioxide; natural-gas hydrocarbons and other substances in aqueous solution may affect the solubility of carbon dioxide at high pressure.

A chart (Figure 5) has been compiled from data available in the literature showing the solubility of pure carbon dioxide in distilled water as a function of pressure and temperature to aid in the solution of corrosion problems. Table 5 shows the sources of data used in compiling the chart which gives the solubility of carbon dioxide in water over a range of pressures and temperatures common in the production of gas and oil. The partial pressure of carbon dioxide (total pressure multiplied by mole fraction of carbon dioxide in the fluid) is the significant pressure in determining the solubility of carbon dioxide in well water. As no experimental data were available in the range of reservoir and flow string temperatures at the low pressures corresponding to common partial pressures of carbon dioxide as a component of natural gas, the values of solubility for this range, indicated in Figure 5 by dashed curves, were determined by graphical interpolation and extrapolation.

TABLE 5

Sources of data used in preparing chart to show the solubility of carbon dioxide in water

Pressure Range, psia.	Temperature of Determination °F.	Reference
30 — 115	32, 40, 70 and 90	8
14.7— 441	32 and 59	9
367 —4,409	53.6 and 64.4	10
367 —5,878	77	10
367 —7,000	87.8, 95 and 104	10
367 —7,000	122, 167 and 212	11
338 —7,000	248	12

Section A of the chart shows the solubility of carbon dioxide in cubic centimeters of gas per gram of water, which is the unit most commonly used in the literature. Section B of the chart, designed to aid in the computation of solubilities based on partial pressures, has two additional ordinate values in other solubility units, each of which can be related to the original unit as follows: Multiply cubic centimeters per gram by 6.06 to obtain cubic feet per barrel; multiply cc. per gm. by 1977 to obtain milligrams per 1000 gm. This last unit, mg. of carbon dioxide per 1000 gm. of water, is equivalent to the unit, parts per million (ppm), when the solution is dilute. A third conversion factor useful in engineering practice is as follows: Multiply cc. per gm. by 0.693 to obtain pound per barrel of water.

For temperature higher than 70° F. the isotherms in Section B of Figure 5 are substantially linear; threfore, to aid in computing solution concentrations corresponding to different partial pressures, the slopes m of the lines are given as follows: 70° F., 109; 100° F., 71; 103° F., 52; 160° F., 42; 190° F., 35; 220° F., 31; and 250° F., 28. The given values of slope m are used in the equation,

$$c = m\,p \quad \ldots\ldots\ldots\ldots\ldots\ 1$$

where,

c = solution concentration, ppm.
p = partial pressure, pounds per square inch absolute.

The importance of the question of solubility is evident when it is realized that the weight of carbon dioxide in a million cu. ft. of a natural gas containing 1.0 mole percent of this component is

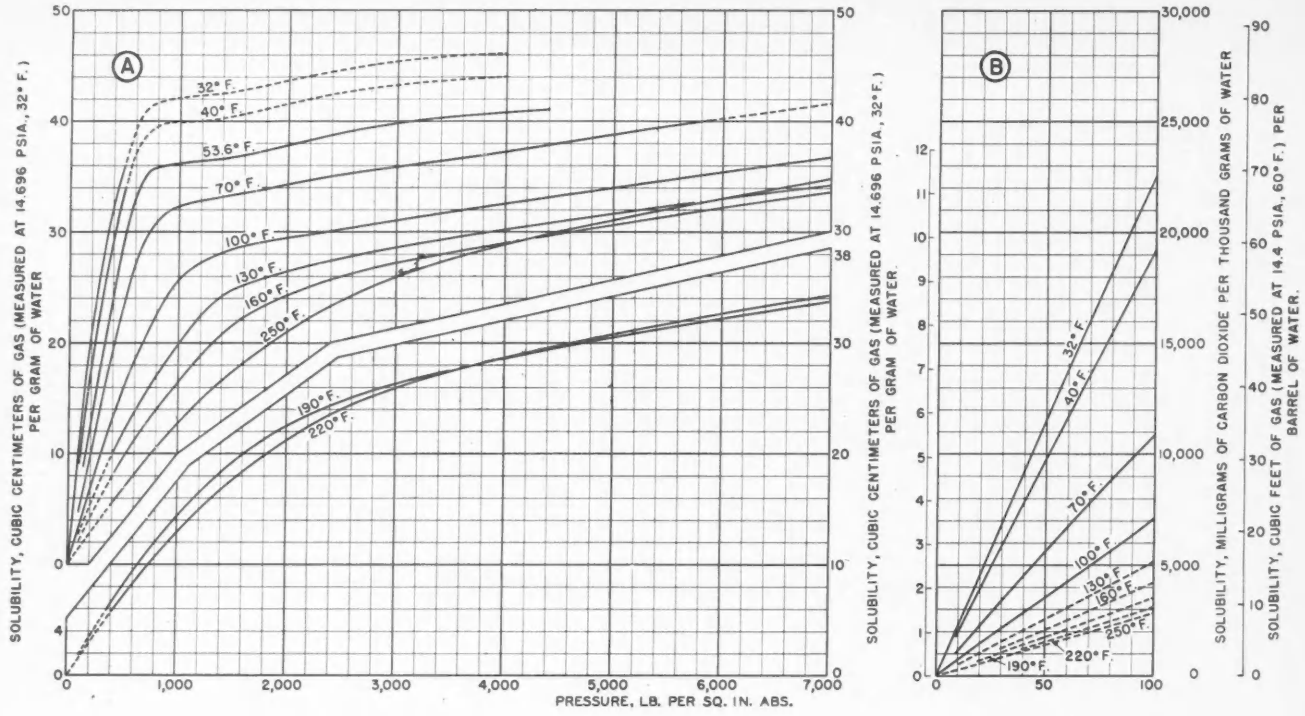
A
B
32° F.
40° F.
53.6° F.
70° F.
100° F.
130° F.
160° F.
250° F.
190° F.
220° F.
SOLUBILITY, CUBIC CENTIMETERS OF GAS (MEASURED AT 14.696 PSIA, 32° F.) PER GRAM OF WATER
SOLUBILITY, CUBIC CENTIMETERS OF GAS (MEASURED AT 14.696 PSIA, 32° F.) PER GRAM OF WATER.
SOLUBILITY, MILLIGRAMS OF CARBON DIOXIDE PER THOUSAND GRAMS OF WATER
SOLUBILITY, CUBIC FEET OF GAS (MEASURED AT 14.4 PSIA, 60° F.) PER BARREL OF WATER.
PRESSURE, LB. PER SQ. IN. ABS.

FIGURE 5. Solubility of carbon dioxide in water at indicated pressures and temperatures.

approximately 1140 pounds. Assuming that the carbon dioxide in this gas would dissolve in water as though it alone were in contact with the water under its partial pressure, one barrel of water would absorb only 1.0 pound of carbon dioxide at a temperature of 77° F. under a total pressure of 3000 psia. (Random tests made by the authors at gas-condensate wells not subject to corrosion have indicated that considerably less than 1.0 pound of carbon dioxide would be absorbed from such gas by flow stream water at the given pressure and temperature). As many wells produce less than one barrel of water per million cubic feet of gas, a large reserve of gaseous carbon dioxide usually is present in the flowing fluid to replenish and control the weight of carbon dioxide dissolved in the liquid-water phase. Treatment of a gas-condensate well to control carbon dioxide corrosion must therefore render the carbon dioxide in solution ineffectual rather than attempt to remove it from the fluid or to convert it to noncorrosive compounds by neutralization.

The pH of Compounds Found in Well Water

The pH of a compound like carbon dioxide or sodium chromate dissolved in the water in the flow string of a gas-condensate well depends to a considerable extent on the effect of other components in solution and on the concentration and temperature. Although the aqueous solutions flowing in gas-condensate wells invariably are complex as to solute content, it is of interest to consider the pH of certain pure components when dissolved separately in distilled water. Figure 6, which shows the pH of a number of substances significant in this report, was prepared using data available in the literature. Values of pH shown in the figure are for a temperature of 77° F. only because most of the data reported in the literature were obtained experimentally at room temperature and atmospheric pressure.

Table 6 shows the data used in plotting the pH curves in Figure 6, together with the concentration range over which the data are applicable and references to the sources of the data. It was necessary to compute the pH of some of the solutes from reported values of ionization constants. For this computation the equations,

$$HA \rightleftarrows H^+ + A^- \quad \ldots\ldots 2a$$

$$BOH \rightleftarrows B^+ + OH^- \quad \ldots\ldots 2b$$

for acids and bases, respectively, indicate simple ionization. The corresponding ionization constants are related to ion concentrations by the equations,

$$K_a = \frac{(H^+)\ (A^-)}{(HA)} \quad \ldots\ldots 3a$$

$$K_b = \frac{(B^+)\ (OH^-)}{(BOH)} \quad \ldots\ldots 3b$$

where parentheses indicate concentrations.

For both acids and bases the measure of the extent to which a solute is ionized was indicated by an equation corresponding to ionization equations 2a and 2b as follows:

$$(M - Mx) \rightleftarrows (Mx) + (Mx) \quad \ldots\ldots 4$$

TABLE 6
Data used in determining effect of concentration on pH of solutions at 77° F.

Solute	Formula	Formula Weight	Ionization Constant Used	CONCENTRATION RANGE		Reference
				Moles per Liter	ppm	
Chromic acid	CrO_3	100.01	T	0.01 —1.0	1,000—100,000	(13) (14)
Formic acid	HCOOH	46.02	2.1×10^{-4}	.001 — .12	46— 5,500	(15)
Acetic acid	CH_3COOH	60.03	1.813×10^{-5}	.000,5— .06	30 — 3,600	(15)
Propionic acid	CH_3CH_2COOH	74.05	1.32×10^{-5}	.001 — .12	74— 8,900	(15)
Butyric acid	$CH_3(CH_2)_2COOH$	88.06	1.50×10^{-5}	.001 — .12	88— 10,600	(15)
Valeric acid	$CH_3(CH_2)_3COOH$	102.08	1.56×10^{-5}	.001 — .06	102— 6,120	(15)
Carbon dioxide	CO_2	44.00	T	.004 — .3	200— 13,220	(8)
Sodium dichromate	$Na_2Cr_2O_7 \cdot 2H_2O$	298.05	T	.000,3— .007	100— 2,000	(16)
Sodium dichromate	$Na_2Cr_2O_7 \cdot 2H_2O$	298.05	T	.02 —1.00	6,000—298,600	(17) (14)
Phenol	C_6H_5OH	94.05	1.06×10^{-10}	.03 — .12	2,820— 11,300	(15)
Sodium chromate	$Na_2CrO_4 \cdot 4H_2O$	234.08	T	.000,6— .3	144— 72,200	(16)
Sodium bicarbonate	$NaHCO_3$	84.01	3.5×10^{-7}	.007 — .03	588— 2,520	(16) (18) (19)
Sodium bicarbonate	$NaHCO_3$	84.01	5.4×10^{-11}	.....	.....	(19)
Sodium carbonate	Na_2CO_3	105.99	5.4×10^{-11}	.....	.....	(19)
Sodium carbonate	Na_2CO_3	105.99	T	.5 —3.0	53,000—318,000	(20)
Sodium hydroxide	NaOH	40.01	T	.01 —1.0	400— 40,000	(21)
Sodium hydroxide	NaOH	40.01	A	.001 — .1	40— 4,000	(22)

T—pH values obtained directly by test and so reported.
A—Computed by use of activity coefficients.

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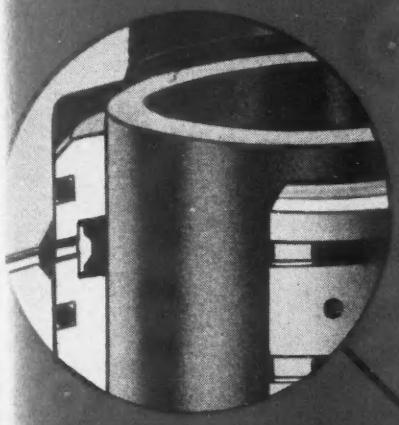
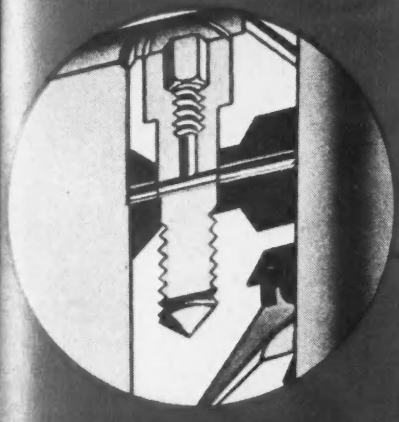
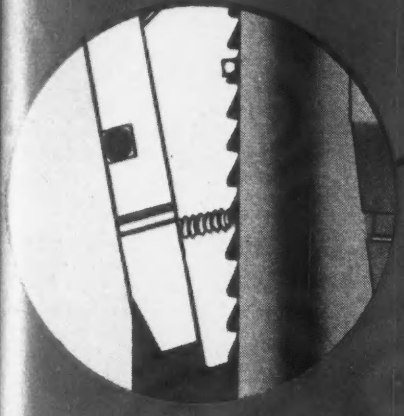


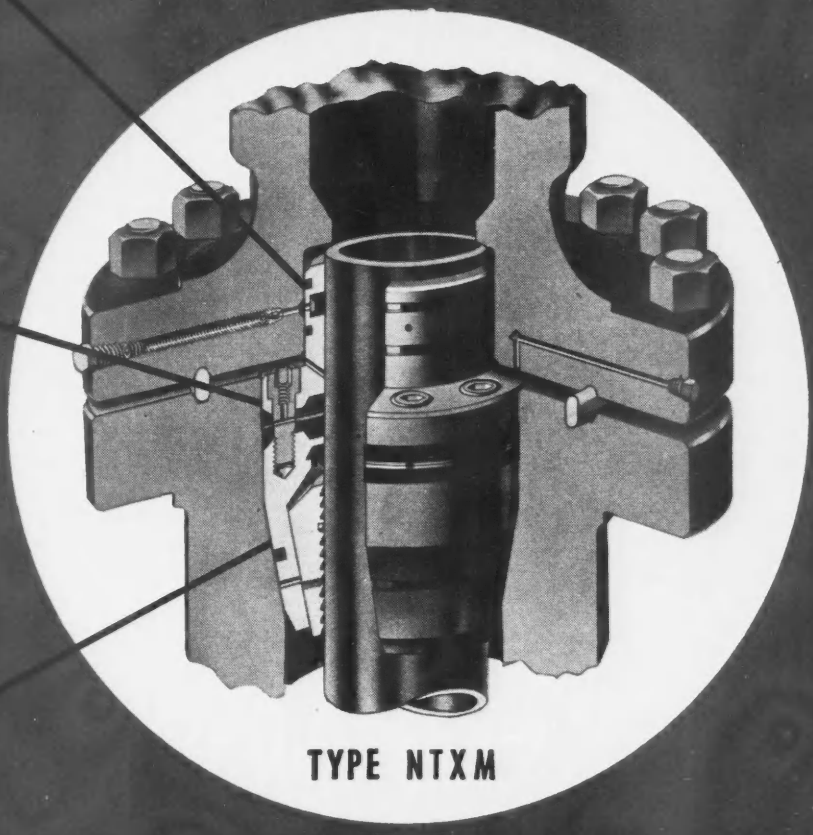
Externally repackable, pre-tested, plastic seal on crossover gland.



Pre-tested resilient seal above slips.



Type "N" slips, with seal ring on slip bowl and lip seal above slips, for temporary but instant seal when setting thru preventers.



TYPE NTXM

Presented above is one of twenty-two interchangeable hanger and seal assemblies for Cameron Forged Steel Casing Heads. This particular assembly combines several proven Cameron casing seals, including the Type "M" seal preparation which has been so widely used in the Cameron Type "M" Test-Weld Flange. This seal may be pressure-tested and repacked at any time during drilling or after the well is completed without disturbing the well head assembly.

The primary casing seal is accomplished by tightening cap screws to expand a resilient seal ring. It may be tested by introducing pressure thru one of the cap screws in which a test port is provided.

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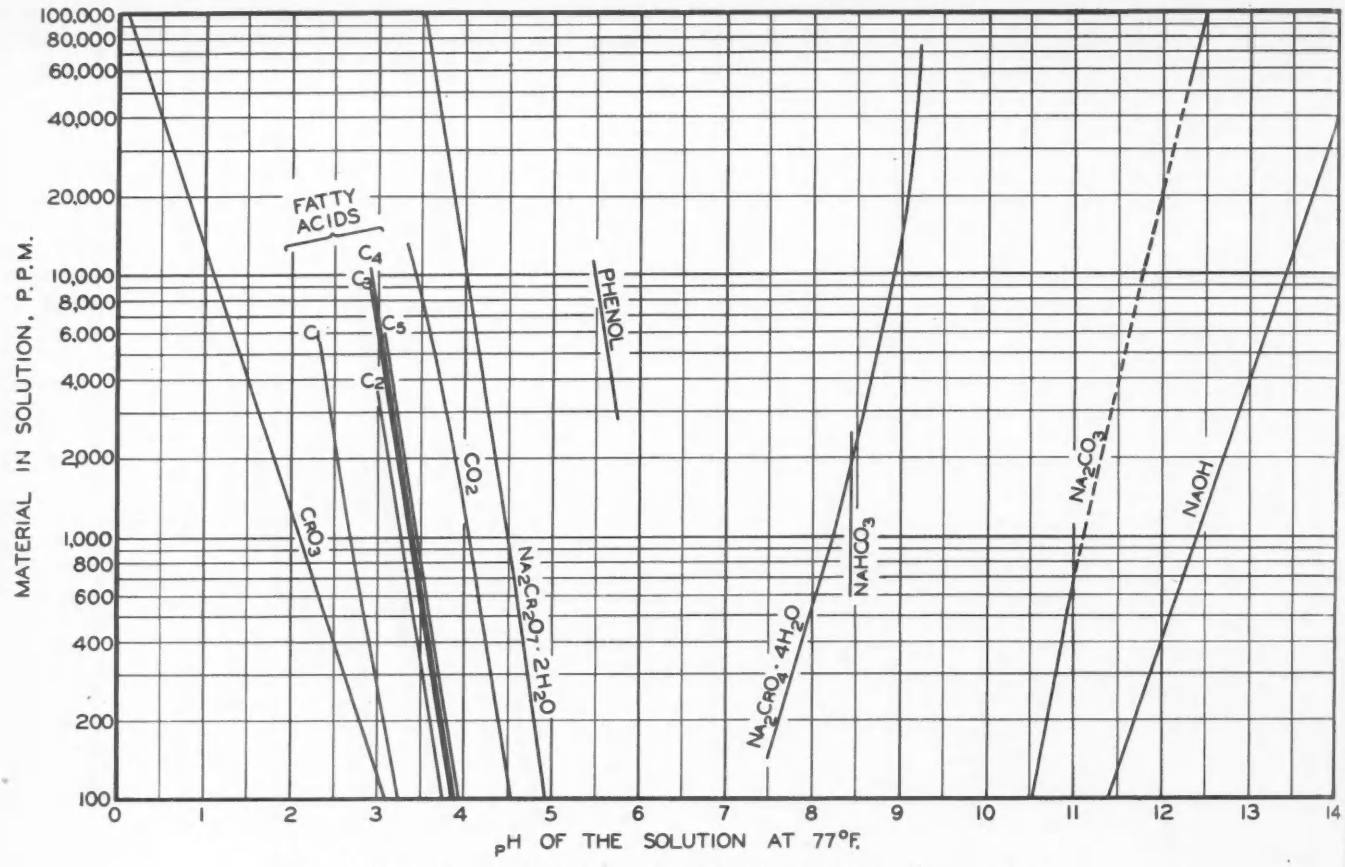


FIGURE 6. The pH of solutions of the indicated materials in distilled water.

where,

M = gram moles of solute per liter of solution,

x = fraction of the solute ionized, and

(Mx) = concentration of the ions H^+ and A^- or OH^- and B^+ depending upon the application.

The ionization constants for the solutes were related to ion concentrations by the quadratic equation,

$$K = \frac{(Mx)\ (Mx)}{(M - Mx)}, \text{ or}$$

$$K = \frac{Mx^2}{1 - x} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ 5$$

by means of which values of x corresponding to chosen values of M were determined. Values of M were selected to correspond to desired solution concentrations expressed in parts per million.

Ion Concentrations

Ion concentrations for acids were calculated from the equation,

$$(H^+) = (Mx) \quad \ldots\ldots\ldots\ldots\ldots\ 6$$

from which,

$$pH = \log \frac{1}{(H^+)} = \log \frac{1}{(Mx)} \quad \ldots\ldots\ 7$$

Ion concentrations for bases were computed by means of the equation,

$$(OH^-) = (Mx) \quad \ldots\ldots\ldots\ldots\ldots\ 8$$

For water at 77° F., the concentration of the hydrogen ion is related to concentration of the hydroxyl ion by the equation,

$$(H^+)\ (OH^-) = 10^{-14} \quad \ldots\ldots\ldots\ldots\ 9$$

and the pH of solutions of bases was computed by combining equations 8 and 9 to obtain the equation,

$$pH = \log \frac{1}{(H^+)}$$

$$= 14 + \log\ (Mx) \quad \ldots\ldots\ldots\ldots\ldots\ 10$$

The pH of sodium bicarbonate solutions could not be computed by these methods because ionization of this important compound is more complex than is indicated by equations 2b, 3b, 4, and 5. Sodium bicarbonate ionizes to sodium and bicarbonate ions the latter of which is further dissociated and also hydrolyzed in accordance with the ionization constants for carbonic acid. Approximate hydrogen ion concentration is given by the equation,

$$(H^+)^2 = K_1 K_2 \quad \ldots\ldots\ldots\ldots\ldots\ 11$$

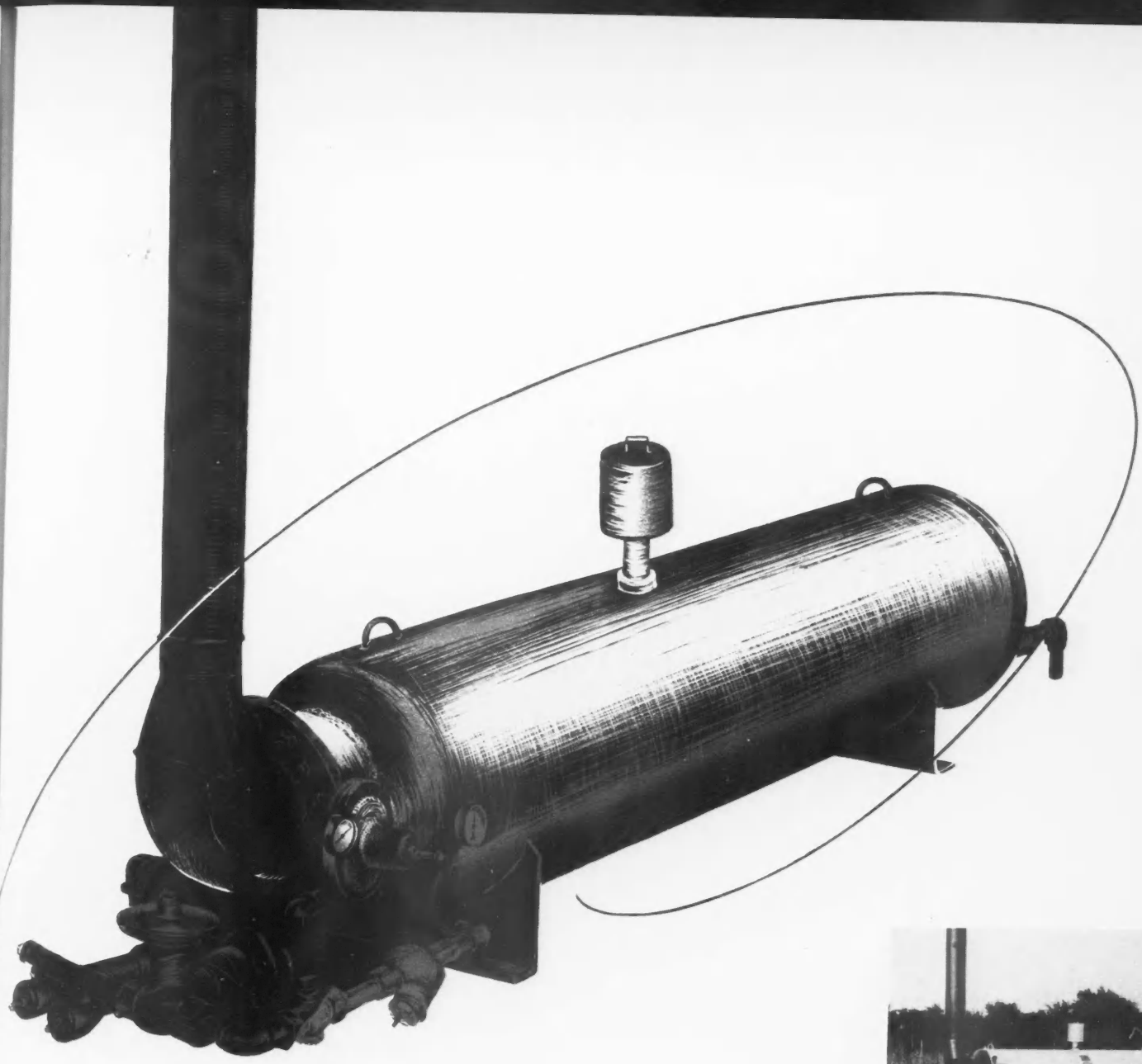
where K_1 and K_2 are the ionization constants for carbonic acid shown in Table 6 opposite the solute, sodium bicarbonate.

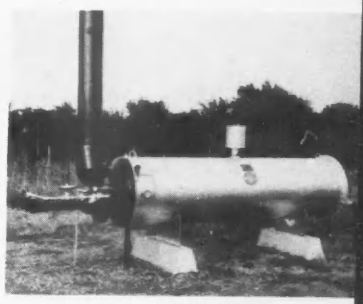
Equation 11 shows that the pH (8.37) of sodium bicarbonate at 77° F. is independent of its concentration. A more exact equation derived by Kolthoff and Furman (23, equation 88, p. 35) indicates only a slight change in pH with dilution; Hartford[16] has suggested that activity coefficients must be considered at high concentrations. Accurate measurements of the pH of sodium bicarbonate solutions are difficult to make and because of the significance of this compound in well water being treated with alkali, it is hoped that additional data on the pH of sodium bicarbonate solutions will be obtained and published.

Except for phenol and sodium bicarbonate, the data illustrated in Figure 6 are substantially complete. Unfortunately, such completeness was possible only at 77° F., whereas, higher temperatures are more significant in the corrosion of equipment of gas-condensate wells. Also, in using Figure 6, it should be borne in mind that the data apply to individual solutions of the pure substances in distilled water, and that foreign materials in solution in well waters may affect values of pH appreciably.

The pH of Chromates in Well Water

The pH of chromates dissolved in water from the test well in the Cotton Valley, Louisiana, field differed appreciably from the values of pH shown in Figure 6 for the same chromates dissolved in distilled water. The results of pH measurements made on solutions of sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$) and sodium chromate ($Na_2CrO_4 \cdot 4H_2O$) in the well water are shown in Figure 7. For the solutions in well water of concentrations greater than 100 ppm





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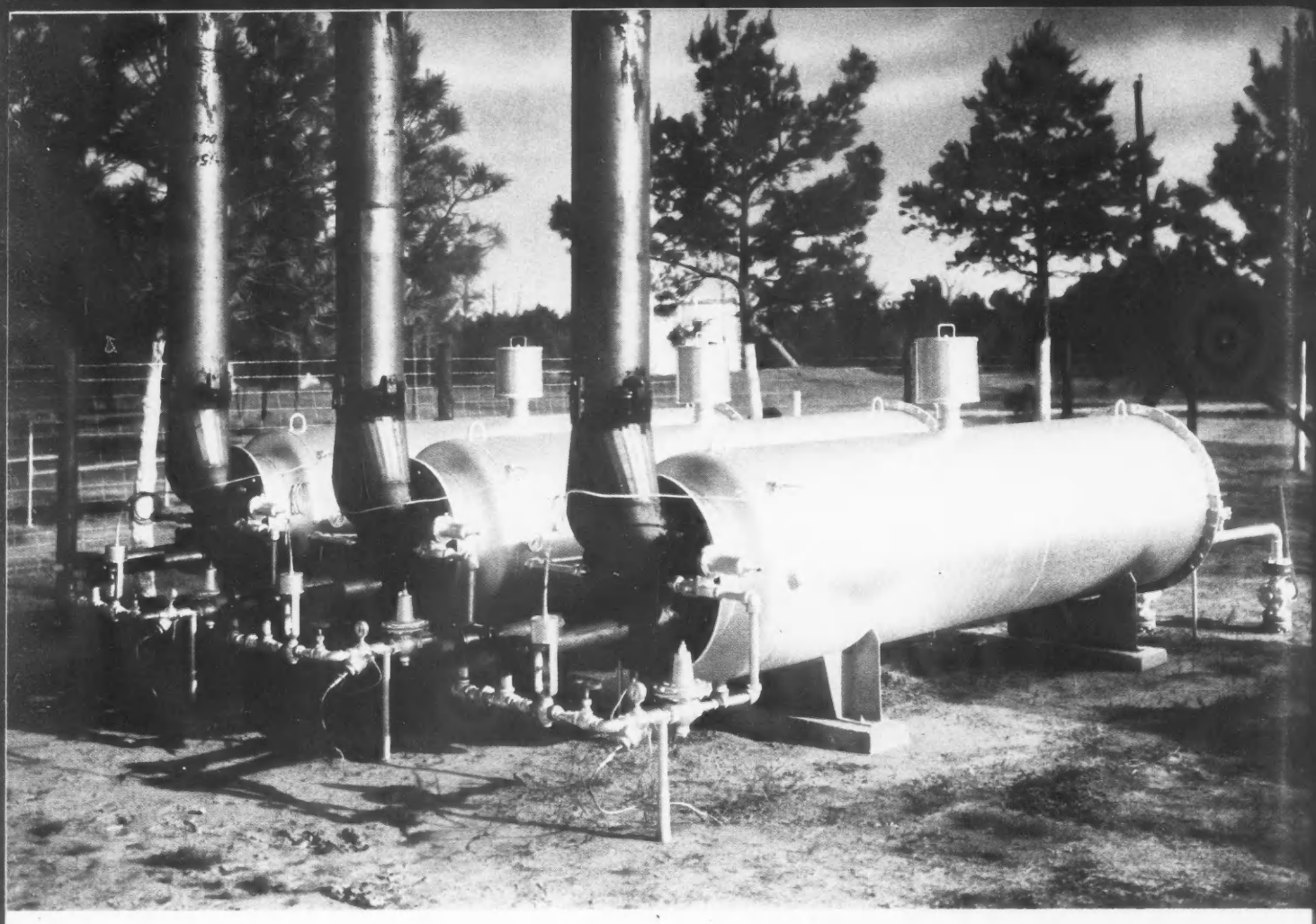

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the pH of the dichromate was higher and the pH of the chromate was lower than the pH of corresponding solutions in distilled water. Such changes in pH can be caused by bicarbonates in the water which, in solutions of high concentration, tend to shift the pH of both the chromate and the dichromate toward neutrality. The water from the test well contained 101 ppm of total solids including 63 ppm of bicarbonates.

Molecular Forms of Chromates

Of the sodium chromates the dichromate or bichromate ($Na_2Cr_2O_7 \cdot 2\,H_2O$) is the most widely used for general corrosion control. Anhydrous sodium chromate (Na_2CrO_4) is more alkaline than the dichromate, and, when used to treat gas-condensate wells, affords the advantage of providing higher pH in the well water than results when an equal weight of sodium dichromate is used. Chromic acid (CrO_3) will provide corrosion control in gas-condensate wells but is more acid than the other chromates and, because of its properties and cost, is not suitable for that purpose. Anhydrous sodium chromate, as manufactured for industrial use, usually contains a trace of sodium dichromate. The hydrated form ($Na_2CrO_4 \cdot 4\,H_2O$) prepared for analytical purposes was used in calibrating the analytical equipment used in the Bureau of Mines corrosion-control investigations.

The relation between the different chromate compounds is illustrated by the following reaction equations which show how sodium hydroxide can be used to convert chromic acid to sodium dichromate and then to sodium chromate. The molecular weights which must be considered in comparing industrially available chromates for purposes of corrosion control are shown beneath the chemical symbols for the compounds.

$$\underset{2 \times 100}{2\,CrO_3} + \underset{2 \times 40}{2\,NaOH} = \underset{298}{Na_2Cr_2O_7 \cdot 2\,H_2O} + \underset{18}{H_2O} \quad (12)$$

$$\underset{298}{Na_2Cr_2O_7 \cdot 2\,H_2O} + \underset{2 \times 40}{2\,NaOH} = \underset{2 \times 162}{2\,Na_2CrO_4} + \underset{18}{H_2O} \quad (13)$$

On the basis of chromium content, 1.0 pound of sodium dichromate is equivalent to $324/298 = 1.087$ pounds of sodium chromate, and 1.0 pound of chromic acid is equivalent to $324/200 = 1.62$ pounds of sodium chromate. In comparing the chromates on a cost basis it should be considered that 1.087 pounds of sodium chromate contains the equivalent of $80/324 = 0.247$ pound of sodium hydroxide in addition to the amount of chromium contained in 1.0 pound of sodium dichromate.

A reason for fluctuations in the pH of well-water solutions of the chromates is indicated by the curve shown in Figure 8. The slope of the curve shows that only a slight addition of sodium hydroxide to a solution of substantially pure sodium dichromate or sodium chromate can cause a considerable increase in the pH of the solution. Data given by Hartford[16] and Britton[24] and data obtained by the authors were used in preparing the figure. The graph shows that chromic acid was titrated with sodium hydroxide to prepare, first, sodium dichromate and, finally, sodium chromate in accordance with the reactions indicated by Equations 12 and 13. The pH of the solution containing chromic acid increased in approximately linear proportion to the moles of sodium hydroxide added until the reaction indicated by equation 12 was nearly complete after which the pH increased by much greater amounts for given additions of alkali. The rate of increase in pH lowered when the reaction indicated by Equation 13 began and then increased as its conclusion was approached.

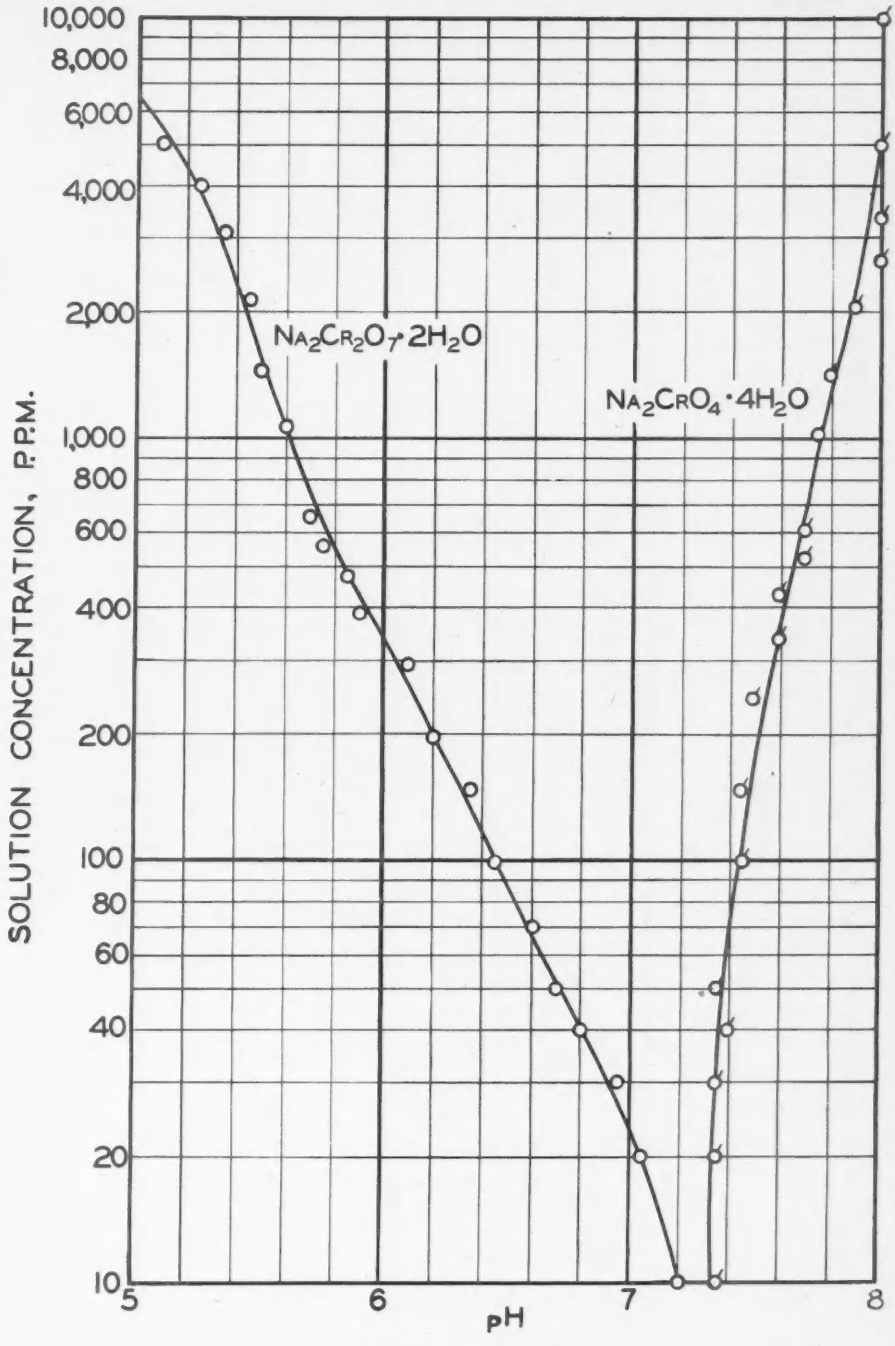

FIGURE 7. Effect of solution concentration of chromates on pH of water from test well.

Because quantities of carbon dioxide are present in a flowing fluid to react with the injected sodium chromate, it is of interest to consider the molecular form of the chromate in the flow stream. The highest pH (measured at atmospheric pressure and temperature) of the water taken from the tubing of the test well in the Cotton Valley field was 8.1. When the water sample was taken in

July, 1946, sodium hydroxide was being injected into the flow stream of the well with the sodium chromate to maintain the highest practical pH. Carbonates in concentrations as high as 1000 ppm were found in the effluent water. On the basis of Figures 6, 7, and 8, a chromate present in water having a pH of 8.1 would be nearly 100 percent sodium chromate.

Carlson[25] and Shock[26] found that the pH of water in the flow stream of a well under tubinghead pressure averaged approximately 0.8 of a unit lower than the pH of the same water after it had expanded to atmospheric pressure and carbon dioxide was released from solution. Assuming that the same pH relation applied to water from the Cotton Valley test well, the maximum pH attained in the tubinghead was $8.1 - 0.8 = 7.3$. On the basis of Figure 8, the chromates in the flow stream at such pH would be predominately sodium chromate with some sodium dichromate. Actually, of course, the pH of the water and the degree of reaction completion in the flow stream is affected by temperature and the presence of dissolved compounds other than chromates.

Industrial Process

In determining the possibilities of an industrial process for converting sodium chromate to sodium dichromate, Neumann and Exssner[27] found that, whereas other acids could completely convert monochromate to dichromate, a water solution of carbonic acid brings about only a partial conversion. The results of their research showed that percentage conversion is favored by low temperatures, high pressures of carbon dioxide, and high concentration in solution. A 70-percent conversion of chromate to dichromate was attained at 32° F. under a carbon dioxide pressure of 147 psia, as compared with a 3 percent conversion of a sodium chromate solution of identical concentration at 86° F. under a carbon dioxide pressure of 37 psia.

In flow stream water having a pH greater than five and less than eight, it seems likely that any injected chromate becomes a mitxure of mono- and bichromates, assuming, of course, that alkali is present to complete the reactions and provide an excess of bicarbonate.

Reduction of Chromates

Experience has shown that the tendency of chromates to be reduced to insoluble oxides of lower valence by hydrocarbons or other substances in the fluid of some gas-condensate wells seriously affects their widespread use. Under certain conditions favorable for reaction, the hexavalent, water-soluble chromates are reduced to trivalent, water-insoluble compounds that may collect on the walls of the tubing and lower its flow capacity. Knowledge of the means of minimizing such reductions is essential for conserving chromates and for attaining maximum benefits from well treatments for corrosion control. Maintaining a high pH in the flow stream water is one of the means of minimizing the reduction of chromates.

Reduction potentials compiled by Latimer and Hildebrand (28, Appendix II) for reactants in molal concentrations at 77° F. show that the acid chromates are more susceptible to reduction than the basic chromates. Hydrocarbons and other reducing agents react with the acid chromates according to the half-equation,

$$Cr_2O_7^{--} + 14\,H^+ + 6\,e^- = 2\,Cr^{+++} + 7\,H_2O,\ E^\circ = 1.36 \quad \ldots\ldots\ldots\ldots 14a$$

which tends to go with a potential of 1.36 volts. Reduction of the basic chromate is according to the half-equation,

$$CrO_4^{--} + 4\,H_2O + 3\,e^- = Cr_2O_3 \cdot \times H_2O + 5\,OH^-,\ E^\circ = -0.12 \quad \ldots 14b$$

which tends to go with a potential of —0.12 volts. The voltages indicating the potentials of reaction are based on the hydrogen - gas hydrogen - ion reference couple,

$$H_2 = 2H^+ + 2\,e^-,\ E^\circ = O \quad \ldots\ldots\ldots 14c$$

Under similar conditions of pressure, temperature, and solution concentration, acid chromates are more likely to be reduced than basic chromates because the reaction potential is highest in the acid medium. The reactions will proceed under other potentials at different temperatures and at lower concentrations of the reactants, and the velocity of the reaction is not necessarily proportional to the reduction potentials. It is indicated, nevertheless, that sodium chromate is less likely to be reduced than sodium dichromate in flow stream solutions of the same concentration and at the same temperature. The results of field tests to be described in detail in subsequent sections of this report showed that the rate of reduction of chromates increased with acidity; chromic acid, which is the chromate of lowest pH, was reduced at the highest rate and sodium chromate, injected with sodium hydroxide to maintain high pH, was reduced at the lowest rate.

Test Results

Test results to be described later indicated that the least weight of chromate is reduced in the flow stream per million cubic feet of flowing gas, when the chromate is injected into the well at a rate just fast enough to provide a slight yellow color indicating an excess of chromates in the effluent water. The weight of chromate reduced per million cubic feet of gas increases if the weight of the chromate injected is increased beyond the minimum that provides an excess of the inhibitor at the wellhead. As the reaction occurs in aqueous solution, it would seem to follow that solution concentration was the governing factor and that even greater saving of chromates would result if quantities of water in excess of the volume required merely to carry the inhibitor in solution were injected into the well. The test results did not confirm this hypothesis and were not positive enough to disprove it. It was clearly shown, however, that one way to minimize reduction of chromates and hence prevent the accumulation of deposits in the tubing was to inject only enough chromate into the flow stream to provide an inhibitor

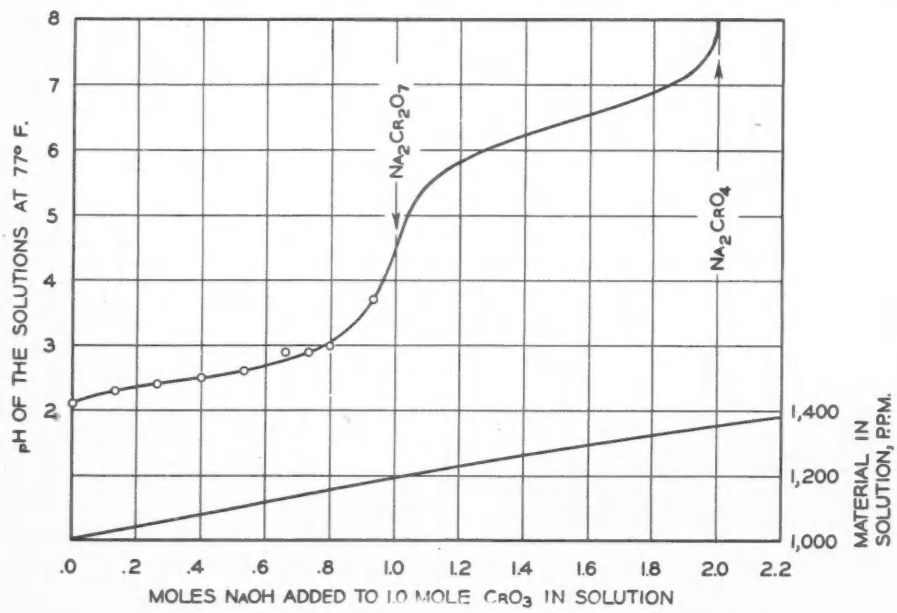

FIGURE 8. The pH of a solution of mixtures of sodium chromates.

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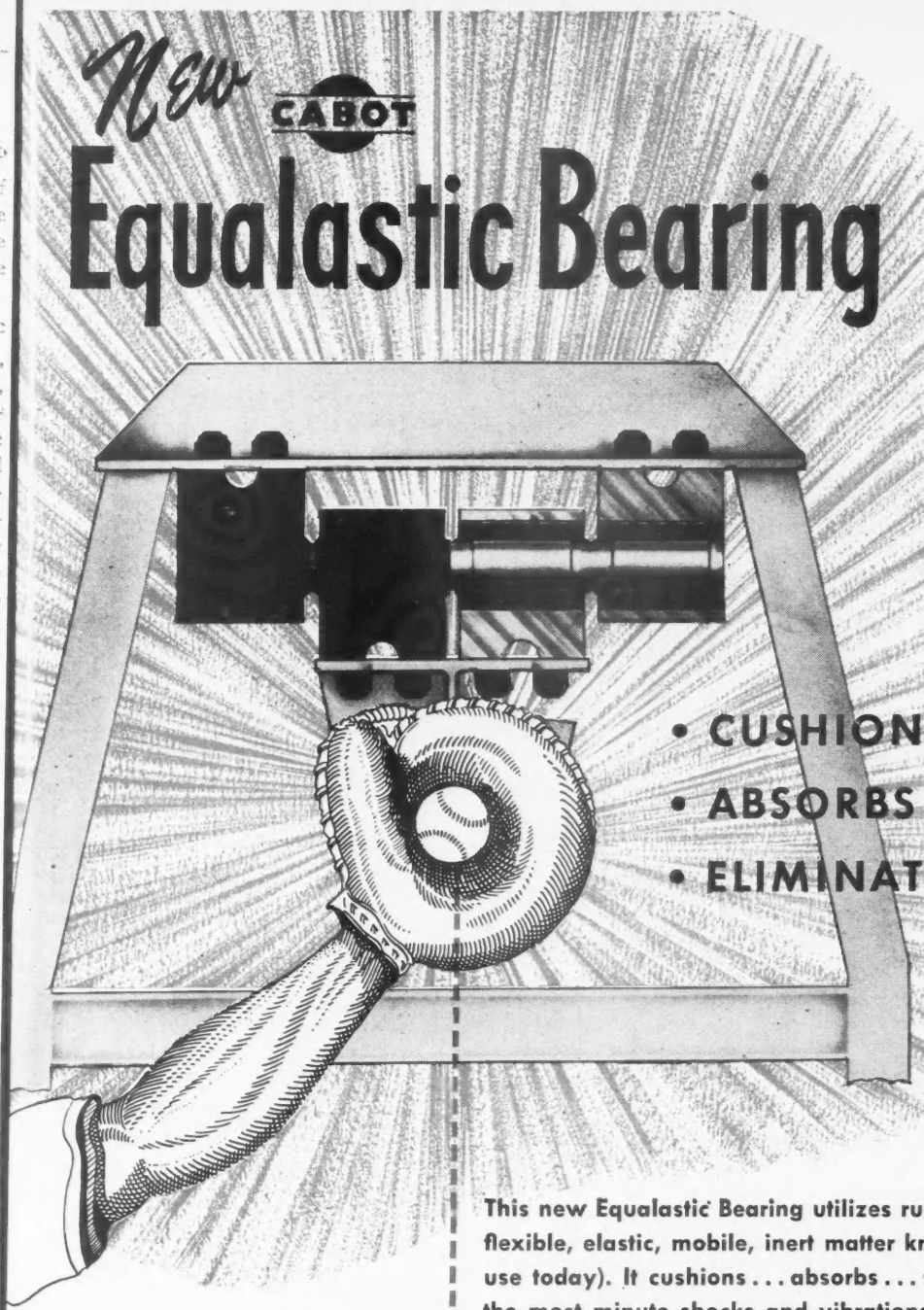

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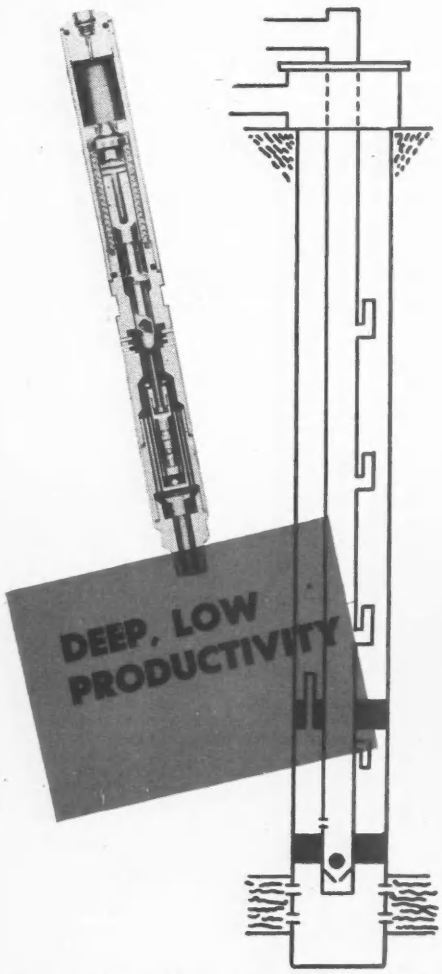

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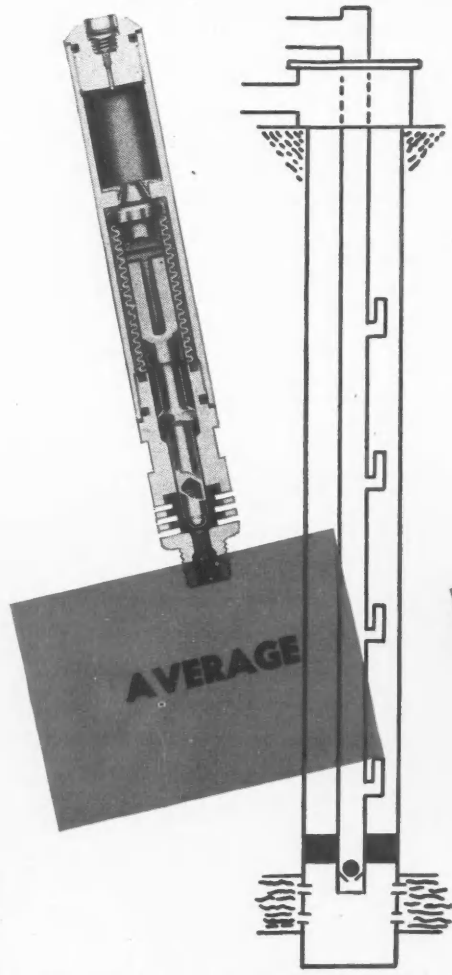
Ordinarily, Type "O" or "O-CF" Valves are used for unloading purposes in these installations. Surface control is provided by the GOT-OLSCO Surface Controller.



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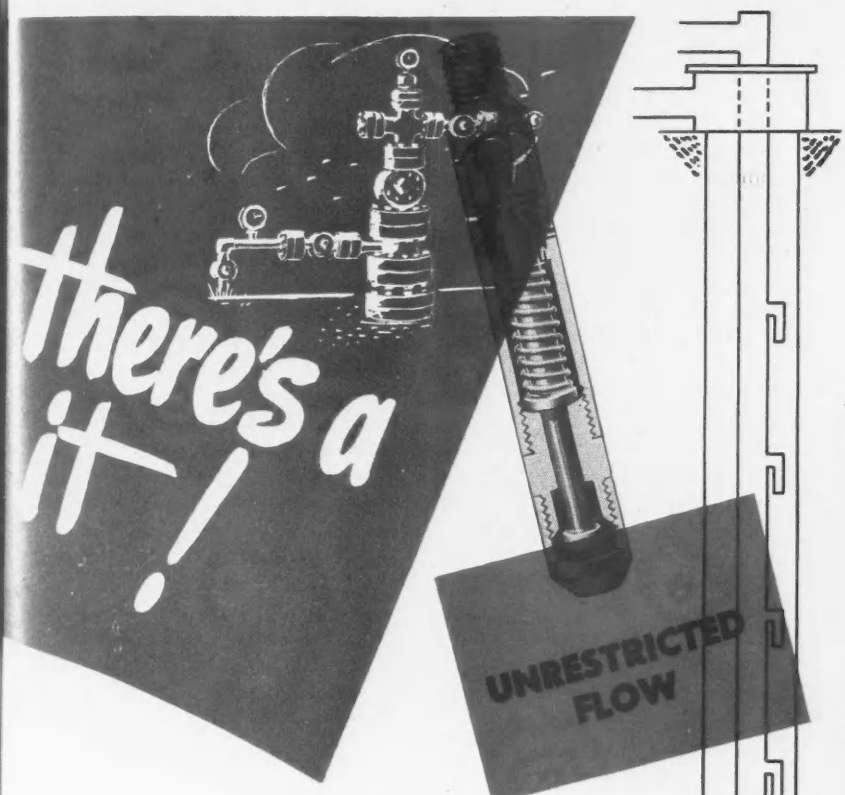
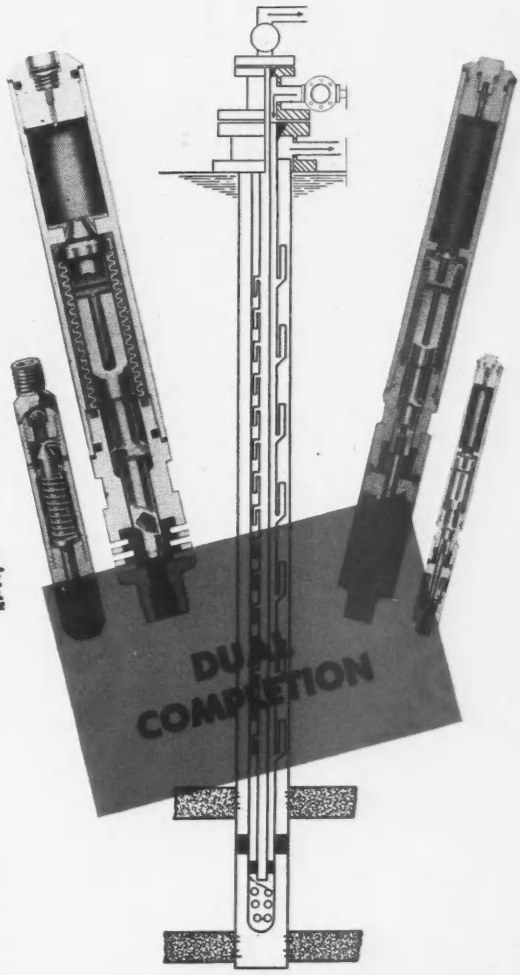
A "Junior" model is also furnished for use macaroni strings.



TYPE "G". A pressure differential, pressure-and-fluid controlled valve, the "G" Valve provides an efficient, inexpensive installation in high volume wells that can be produced at maximum rates without surface restrictions. Installed on the tubing string, they are adaptable for flowing through the tubing, or through the casing annulus.

Also furnished in "Junior" models, for use on macaroni strings.



Here is the most complete line of gas lift valves in the world . . . valves that meet every producing condition and permit gas lifting any well in existence.

These valves were developed to meet well conditions . . . **and each provides unequalled efficiency in a certain type well and under certain conditions. Sufficient operating flexibility is maintained in each design to provide for normal well variances and to permit selection and installation of the proper valves under estimated or approximate well conditions.**

On standard installations, the tubing is left full open past the valves, permitting use of pressure bombs, paraffin scrapers and other sub-surface instruments. For use with macaroni tubing and in dual completion wells, each valve is also furnished in a "Junior" model.

GOT-OLSCO also provides *service*, with two modern plants and with experienced representatives stationed at strategic points in most active areas.

With this complete selection of GOT-OLSCO Valves, and with efficient compressor plants to furnish low cost injection gas when a natural supply is not available, there is no longer a limitation on gas lift . . . any well can now be produced by this most economical method of artificial lift.

For complete information on GOT-OLSCO Gas Lift equipment and services, contact your GOT-OLSCO representative or write to our Houston office.

GOT-OLSCO Gas Lift Valves provide a highly efficient and successful means of secondary recovery in dual completion wells, permitting selective production of either zone or simultaneous production of both zones in any type of dually-completed well. In these wells, two strings of pressure-charged valves may be used; or, one string of pressure-charged valves and one string of pressure differential valves.

With an efficient check valve system that prevents intermingling of fluids, GOT-OLSCO Dual Completion Installations meet full approval of regulatory bodies.

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throughout the entire length of the tubing with an excess at the wellhead that can be readily recognized.

The sediment of the reduced chromium compound recovered in a trap on the tubinghead of the test well was gray to green and contained numerous friable granules of the same material. Analyses have indicated that the water-insoluble chromic compound had the molecular form $Cr_2O_3 \cdot x\,H_2O$. This compound is a hydrous chromic oxide and is often referred to as "reduced chromate" or "reduced chromium compound."

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(To be continued)

Oil Production by Gas and Flooding

■ CONTINUED FROM PAGE 170

row which is less than proportional to strike distance on radial reservoirs. The symbols G, B and M have the same significance as in Figure 10-6. However, the B-M and G-B distances may be comparatively greater by virtue of convergence.

The number of wells on an initial injection row may be considerably less than on a first row of producing wells. Areal by-passing of oil within a given interval is eliminated by shutting in at breakthrough the producing wells on the nearest rows. This procedure makes the ratio of the dip distance advanced by water to the distance between injection wells high enough to achieve unit invasion.

Number of Producing Rows

The number of rows producing oil by water seldom exceeds three for a flooding project. Although some oil migrates across a third row of producing wells, the rate of oil production by water from the fourth and other rows is practically negligible. Such oil as is produced at a given time from wells on the downstream side of a third row is by gas only. Hence, the number of rows producing oil by flooding need not be greater, but may be less, than three. The question now arises as to what is a row of wells.

The ratio of wells for two rows on a linear reservoir is on the order of unity, that is, each row has about the same number of wells. For elongate reservoirs, the last row of wells is along a major axis. Offset wells to those on a major axis are in the next to last row and so on for additional rows. When the ratio of wells not on a major axis to the wells on the major axis is two or three, the reservoir is said to have two or three equivalent rows. In the case of radial reservoirs, the last row has only one well. Let there be r rows. The first row contains $6(r-1)$ wells for staggered spacing or $8(r-1)$ wells if spacing be regular. The ratio of updip wells to the wells on the first is unity for a four-row radial system. We would say that a four-row radial system is equivalent to a two-row linear system. A six-row radial system having either staggered or regularly-spaced wells is equivalent to a three-row linear system. As the number of wells on the first row of a three-row radial system of wells is greater than for a three-row linear system, the migration across a third radial row is less than that across a third linear row. Accordingly, not more than three equivalent rows are required in order to produce oil at about the same rate oil is being displaced by water at a given time.

Evaluating Gas Functions In Oil Production

■ CONTINUED FROM PAGE 162

geologic structure of the reservoir rock, a knowledge of the character of the natural gas in crude oil as both exist together under pressure and temperature conditions existing in the subsurface reservoir which would utilize gas-injection pressure-maintenance from the beginning or from early in the productive life in the field can lead to a recovery of from 50 to 75 percent of the recoverable oil-in-place from any gas-drive type reservoir. Unless the energy represented by compressed gas in the reservoir is utilized only for the purpose of expelling oil from the reservoir, and unless reservoir pressure is maintained by re-injection of the produced gas so as to utilize re-injected gas to drive additional oil to well bores, the percentage recovery of oil in place will be less than the maximum economically possible. It is the lack of opportunity to conduct pressure-maintenance operations in gas-drive reservoirs that is the crux of the conservation problem in that type of pool.

Research sponsored by industry seeking economic improvement will always go forward under a system of competitive, free enterprise. The question of prime interest is how much more research needs to be done and how quickly can the research be accomplished to bring about a greater conservation of crude oil and natural gas resources in gas-drive type reservoirs. That question can draw a general answer in the observation that nothing fosters research and the development of a technical basis for the economic improvement of an industry more than does the opportunity to apply the results of such research to actual practice. To be sure, many avenues of investigation remain open which would be worthwhile to follow in order to develop more detail and more definite understanding of the reservoir processes in gas-drive type reservoirs.

There are advancing steps yet to be taken but the fact is that the progress that has already been made from both a purely laboratory investigation point of view, as well as from actual field practice, has been such as to lift the technical knowledge to a level far above that of the applications that are generally made in practice. The industry, in many instances, is somewhat in the position of the farmer who expressed no need for a book on agriculture for the reason that he wasn't then farming as well as he already knew how.

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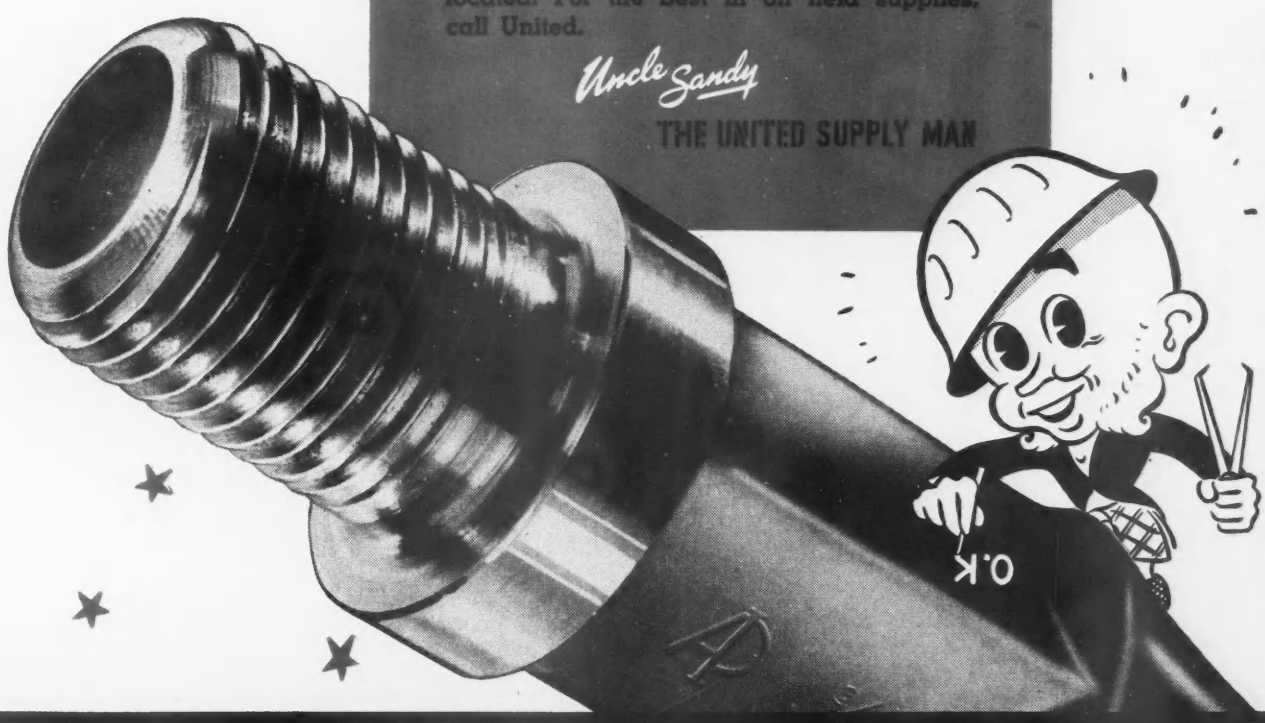

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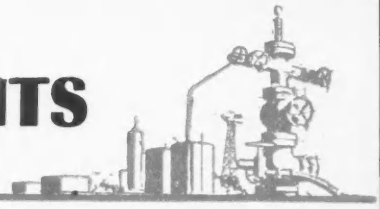
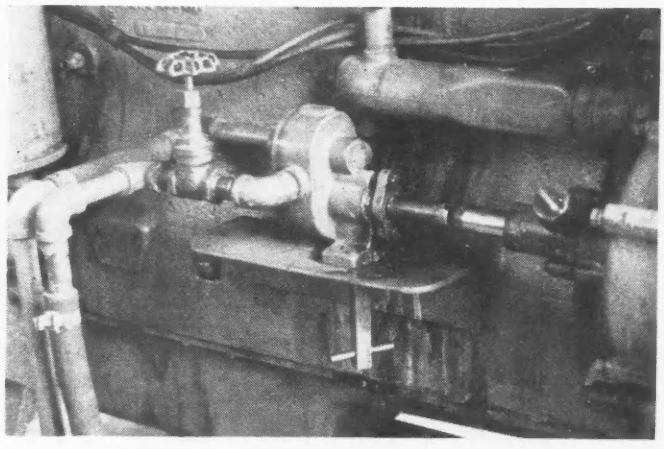
PRODUCTION HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

HOW TO—Mount Sump Pump on Station Engine

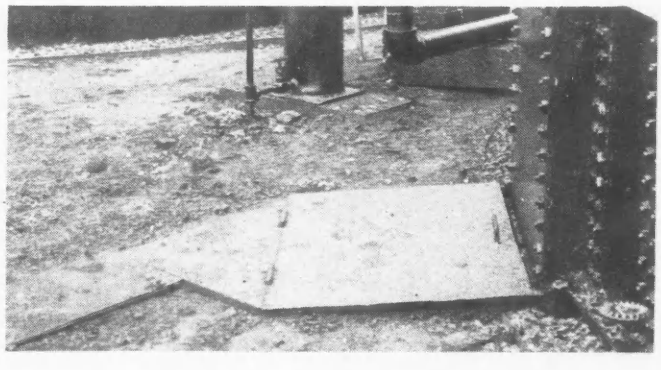
Where circulating pumps handle jacket cooling water, or water over the cooling tower, the accumulation of waste water draining into the pump room sump can be disposed of without installing a separate unit for this purpose. A method used to handle the waste water is to place a small gear pump on the side of one of the gas engines with suction and discharge piping attached. These engines have milled faces on the side of the crank case for separate generators and water pumps, but since ignition and starting is accomplished with units separate from these engines, the faces are blank.



A sturdy steel bracket is fastened to a face to align the gear pump shaft with the extension drive shaft which would drive an individual water circulating pump for the engine jackets. The gear pump is attached to the bracket with a manually-tightened mounting bolt which is inserted through a slot in the bracket in order that the gear pump can be moved horizontally with the engine. A simple dog clutch is supplied to form the connection drive for the gear pump so that, when this pump is slipped forward to the front of the engine, the clutch is engaged. As this engine is used alternately every other day with a companion, the gear pump is connected before the engine is started so the sump can be pumped out. When the water is moved out of the sump, the mounting bolt is loosened and the gear pump slipped backward which disengages the dog clutch.

HOW TO—Cover Drainage Flume of Stock Tank

Production stock tanks in areas where crude contains paraffin and sludge require frequent cleaning to remove the bottom sediments that accumulate. To facilitate the cleaning job, the manhole opening was extended six inches so that its edge protruded into a concrete flume.



By extending the manhole in this manner, the plate cover could be removed and replaced easily since the bolt heads are exposed on the outside and thereby made accessible. The flume is a concrete ditch constructed to handle the sludge and sediments which accumulate in the stock tanks. It is widened at the tank manhole extension so that when the manhole plate is removed, all sludge will drain into the flume.

Each stock tank is equipped with similar drainage flumes that lead into a common pit where the sludge can be disposed. For safety, reduction of a fire hazard and cleanliness, the open concrete ditches are covered with metal plates. A hinged cover is added to the enlarged box receiver in front of the manhole. It is fitted with a handle so that the cover can easily be swung back when the tank is to be cleaned. After the job is completed, the cover is again laid down in place where it completely covers the concrete flume and the sludge contents.

The job of cleaning out production stock tanks frequently has been speeded and the disposal of sediments was made simple. The covers prevent personnel from stumbling over the concrete flumes, as well as reduce the fire hazard.

D+B Rod Liner PUMPS

FOR THE MOST SEVERE PUMPING SERVICE
WHERE ONLY FINEST QUALITY PUMPS SURVIVE

D+B Rod Sectional Liner Pumps are designed, engineered and constructed to provide efficient and economical service under the most severe operating conditions. The precision sectional liner provides a straight, true liner column through which plunger can operate freely.

The advanced design, combined with use of highest quality materials and precision workmanship make D+B Rod Liner Pumps unsurpassed for efficient handling of gassy, sandy or corrosive production from "problem" wells. They are available in a full range of sizes and lengths, with any desired combination of fittings to efficiently pump from any depth in any well condition—a fitting complement to the world famous D+B line of deep well pumps and sucker rods.

STATIONARY BARREL WITH TOP OR BOTTOM HOLD-DOWN

Recommended for corrosive, sandy or gassy production from crooked or slant holes. Regularly equipped with chrome-plated plungers, H-C-I or "Endurall" liners, double valves, Armored or Endurall closed cages, and Superloy balls and seats. Available with either 3-cup or exclusive D+B Simplex top or bottom lock hold-down.

TRAVELING BARREL WITH BOTTOM HOLD-DOWN

Recommended for gassy and sandy production. Particularly effective in moderate sandy conditions with intermittent operation. Standard equipment includes chrome-plated plungers, H-C-I or "Endurall" liners, double valves, Armored closed cages and Superloy balls and seats. Available with 3-cup, A.P.I. or exclusive D+B Simplex bottom lock hold-down.

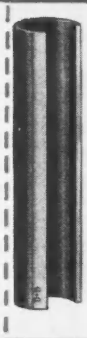
TRAVELING BARREL CHAMPION WITH BOTTOM HOLD-DOWN

An inverted insert type pump with either 2 or 3 liners and extension tube. Plunger acts as both pull tube and plunger, reducing number of parts and joints. Recommended for sand, shale, or corrosive well conditions. Wiping action of short liner column prevents intrusion of sand between working surfaces. Oversize standing valve, connected to upper end of plunger, permits free, unobstructed fluid flow.

CHROME-PLATED PLUNGERS

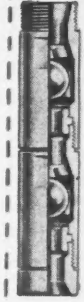
All D+B Rod Liner Pumps are normally equipped with chrome-plated plungers. They are made from thick-walled, seamless steel tubing, heavily chrome plated. They are accurately ground and polished to size and fit desired to assure a perfect seal. D+B "Endurall" plungers for extreme corrosive service may be used.

LINERS



Hardened cast iron (H-C-I) liners for ordinary pumping, or stainless steel "Endurall" liners for severe service, are normally supplied with D+B Rod Liner Pumps. All D+B liners are centrifugally cast to provide a uniform dense structure free from impurities. They are honed to a mirror-like finish and have a precisely controlled hardness for maximum wear resistance. Standard and Armored liners are available.

DOUBLE VALVE ASSEMBLY



D+B Rod Sectional Liner Pumps are equipped with double valve assemblies. They are designed to permit free, unobstructed fluid flow and to provide correct amount of ball lift and side clearance. Gas spinning of ball is eliminated. In operation, the double valve assembly insures perfect seating and long, trouble-free service.

For additional information on D+B Rod Liner Pumps ask for Bulletin No. 611-A

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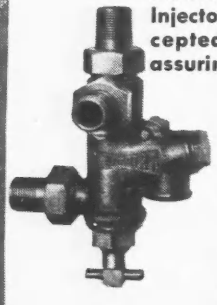
D+B

DEEP WELL PUMPS AND SUCKER RODS

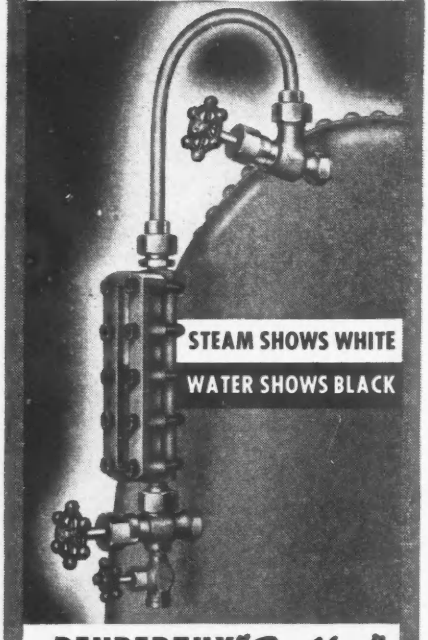
PENBERTHY Drilling Hints

Drilling contractors have long found that it pays to standardize on Penberthy products because of their exceptionally rugged construction and their dependable performance under the most severe operating conditions.

PENBERTHY INJECTOR



Penberthy Automatic Injectors are the accepted method of assuring an uninterrupted supply of feed water to boilers at minimum cost. They are quickly and easily installed—require little attention.



PENBERTHY "Reflex" WATER GAGE SET

Water level cannot be misread because steam always shows white and water black. U-Bolt construction permits replacing glass by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler. 3277-D

PENBERTHY PRODUCTS

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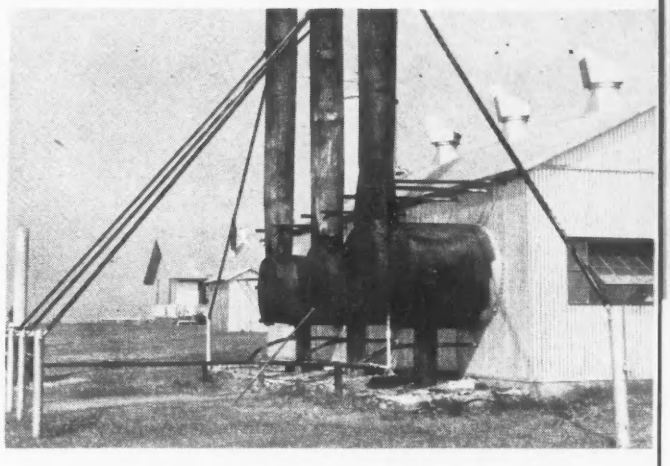
HOW TO—Guy Tall Boiler Stacks



Stationary boilers required for steam generation are usually housed in permanent fire-proof steel buildings which afford equipment protection against weather. In many cases, these boilers are of the oil field type, and are equipped with unusually tall stacks in order that a good draft can be maintained.

These high stacks require rigid guying if they are to withstand high winds. A battery of three boilers with such stacks is illustrated. The stacks are supported by 1½-inch pipe instead of guy wires. Each stack is braced to the adjacent one by means of connecting pipes welded to hoops that clamp around the upper end of the stack. These hoops provide a means to which a hinge connection can be made with the guying pipes.

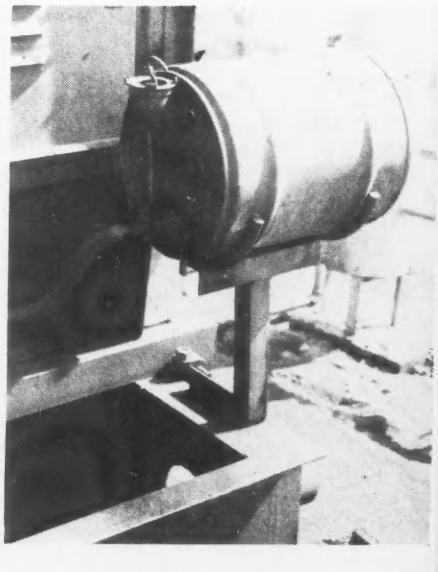
The end stacks are supported by two such pipes while the center stack is supported by one which extends in front of it. However, all stacks receive equal bracing since they are tied together by the cross braces.

The guying pipes are terminated at anchor posts which are set in concrete and extend about five feet above ground. This construction provides sufficient unobstructed space so that personnel or trucks can pass below without interference.

HOW TO—Make Oil Reservoir Stand

A crankcase oil reservoir rack which combines neatness, ease of installation or removal, and economy of materials in construction, is contained in the installation shown. The small drum serving as the reservoir is set up on a rack made of only two pieces of angle iron and a pair of curved steel arms, the latter forming a cradle in which the drum rests. Bolted to any convenient part of the engine sub-base, the leg and base of the rack are made from a single piece of angle iron which is cut, bent and welded into a right angle section as shown. Across the top of this piece is welded a short horizontal piece of similar material. Previously-formed, curved lengths of round bar then are welded to the horizontal member.

Design of the installation is such that the full weight of the drum falls upon the vertical leg, while lateral movement caused by vibration or accidental bumping or rolling of the drum is resisted by the bottom anlge section which rests upon the engine base.



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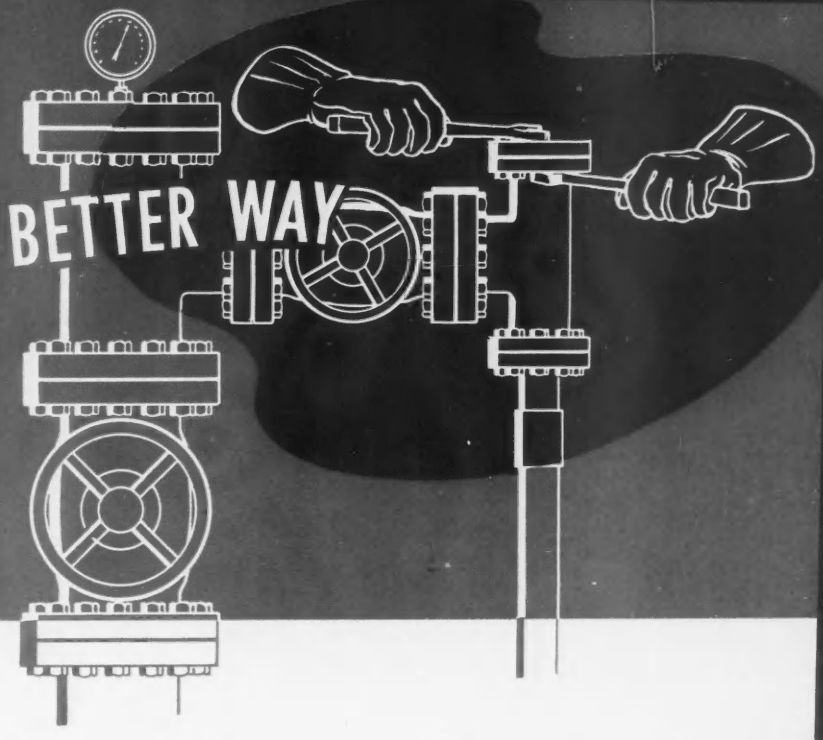
TO DO THIS JOB!



UNIBOLT TEE OR CROSS WITH BLANKING PLUG—available in any desired combination of inlet and outlet sizes and pressures.

UNIBOLT POSITIVE CHOKE—release only one bolt to change chokes in this regular UNIBOLT Choke Body fitted with UNIBOLT Flow-Rated positive bean and Blanking Plug.

UNIBOLT ADJUSTABLE WING VALVE—can be assembled in manifold for flowing with or against the stem. Provides economical wing valve, with unrestricted flow, for shut-off while changing beans.

Employing standard UNIBOLT connections rather than flanges, the UNIBOLT Manifold is many pounds lighter, yet the unique UNIBOLT design, which places more steel in shear, actually results in a higher factor of safety for the manifold.

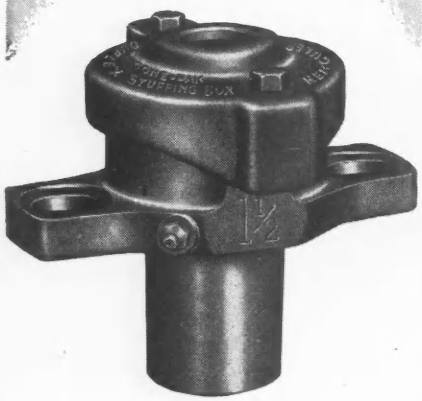
Here are other reasons why more and more operators are specifying UNIBOLT Flow Manifolds as a better means of controlling well flow: (1) Units of the manifold . . . Unibolt Adjustable Wing Valve, Unibolt Positive Choke Body, and Unibolt Tee or Cross . . . are pressure-tested as a unit and may be assembled in a number of combinations to best meet individual requirements; (2) Any desired volume of well flow may be accurately achieved with UNIBOLT Flow-Rated Beans, which are available in flow increments of 5% and 10%, or in standard fractionally drilled sizes; (3) Lower first cost and maintenance; (4) All parts may be safely and easily replaced in the field; (5) Its units are completely interchangeable; (6) The manifold is completely salvageable; (7) It is available in regular forged steel or in high-chrome alloy for corrosive wells—6000 lbs., 10,000 lbs. and 15,000 lbs. test.

UNIBOLT
THE ONE BOLT COUPLING

NEW

HERCULES LUBRICATING UPPER GLAND

Protects polished rod and liner against excessive wear



Designed with a minimum of parts for easy installation and economical operation. This new lubricating gland lengthens the life of the rod or liner as well as the packing in the stuffing box. On various tests, the life of the polished rod or liner and the packing in the stuffing box was increased many fold. Equipped with a zerk fitting to insert bearing grease and with a regular Hercules cone packing ring, serving as a wiper ring. Fits all type Hercules stuffing boxes now in use.

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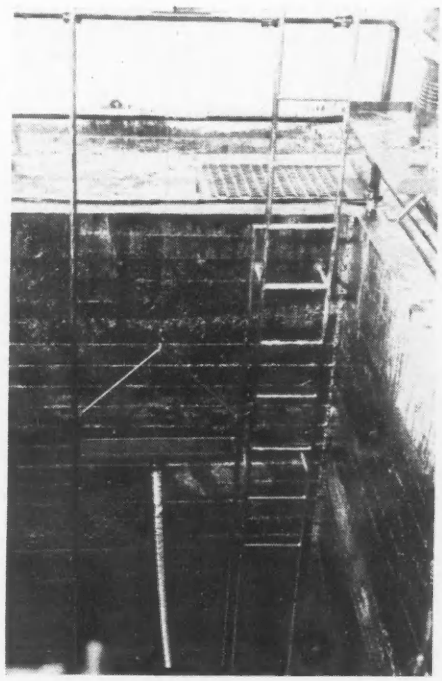
HOW TO—Build Oil Sump Skimmer

An effective, easily constructed oil skimming device applicable to many types of oil sumps or waste oil pits is used by one company in a sump adjacent to one of its tank forms. It consists essentially of a horizontally mounted tray made of a split section of eight-inch casing, which is moved up and down between two vertical parallel pipe bars. Fitted with a bail and provided with a drain to which is attached a length of flexible rubber or composition hose, the skimmer is adjusted to the desired level by means of a light hand-powered reduction gear winch mounted within easy reach from the top edge of the sump.

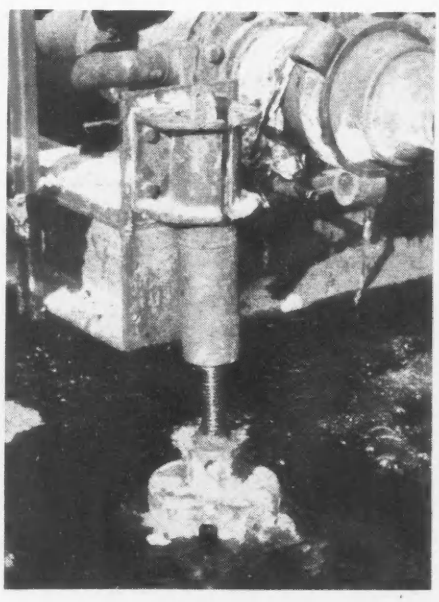
Oil skimmed from the top of the fluid level is drained through the hose to another reservoir from where fluid is picked up by a sump pump and delivered to a nearby tank. The relatively large effective skimming area of the device, plus the fact that it can be adjusted easily to within a fraction of an inch of the optimum level, makes the device especially desirable when large volumes of waste fluids are to be handled. A ladder beside one of the vertical runners or guides, and extending to the bottom of the sump, simplifies repair and inspection of the skimming device.



HOW TO—Support Mobile Pump Unit

Mobile pumps, installed on a trailer chassis, are frequently cribbed at the corners with timbers to relieve the tires of weight load while the pump is in operation. One producer uses screw jack parts for cribbing by cutting the foot from the jack barrel and welding the part, inverted, to a bracket attached to the corner of the chassis frame. If the pump is set on ground which is soft or unconsolidated, a block of wood is laid down whereon the head of the jack is provided solid footing.

The conventional jack bar is used to adjust the jacks at each corner to stabilize the unit so connections will not be shaken loose by continuous vibration during operation. When the pumping unit is to be moved to another sump hole or tanks where fluid is to be handled, the screw shaft of the jack is removed from the barrel and screwed in the top where the extension of the bracket serves as a place to store the threaded shaft and head until required at another setting.



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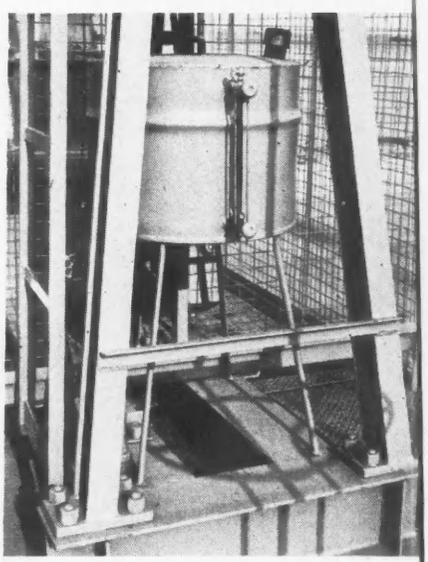
HOW TO—Facilitate Constant Pumping Unit Lubrication

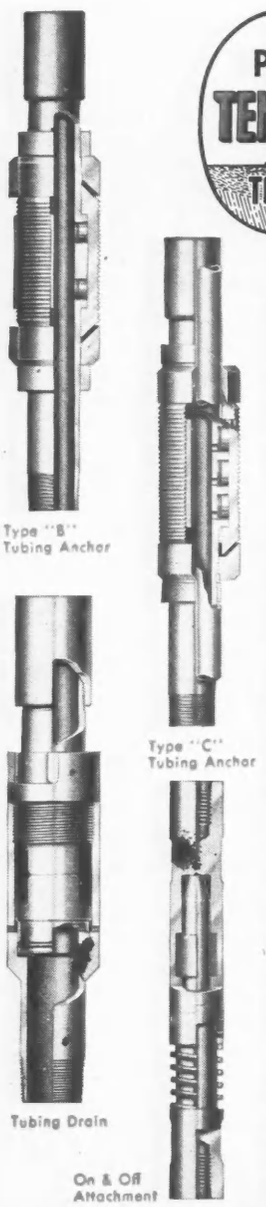
Maintaining constant lubricating oil level in the gear reduction boxes and crank cases of engines used on pumping units is a job of prime importance to the pumper. Where it is necessary for one pumper to look after a large number of pumping wells, anything that can be done at each well to facilitate maintenance will be valuable.

It is common practice for the pumper to carry a drum of lubricating oil to fill the gear box to operating levels and for other greasing purposes. The hint illustrated here was designed primarily to eliminate this practice, and to replace it with a handy supply at the well. A shop-made lubricating oil container is shown. It consists simply of a salvaged steel drum that has been cut in half and sealed over the top with light gauge sheet metal welded to the upper edges. A filling and breather cap was added near one edge, and a handle made of sucker rod was welded to the center so the container could be removed easily.



A gauge glass assembly was added to the front side of the container by welding couplings at the upper and lower connections to the gauge glass. The container rests on four legs made from sucker rod material that have been welded to the pumping unit foundation frame. The legs are not fastened to the container in order that the vessel can be removed if necessary. A connection is made on the side near the bottom and the line is equipped with a valve, partly visible between the ladder and sampson post. The connection leads to the engine crank case and the gear reduction box. The oil level in these two units can be carefully controlled from this reservoir supply.

The container is mounted below the walking beam just behind the sampson post for protection and ease of refill. Note caged-in section of pumping unit in background.



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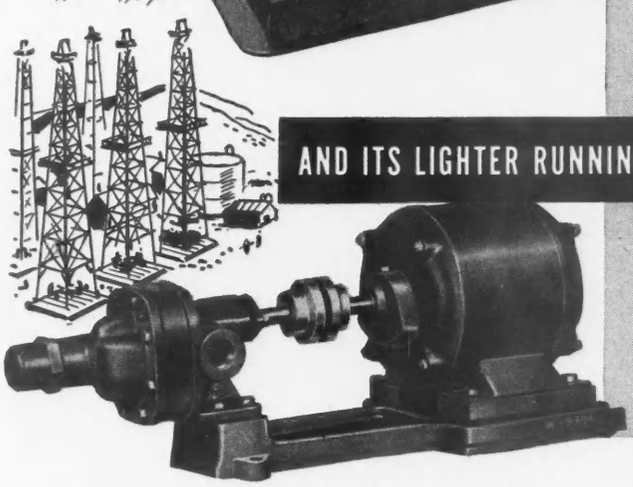

Worthington Rotary Pump, Type GA, motor drive. Capacities to 51 gpm. Pressures to 100 psi. Foot or flange mounted, with or without relief valve.

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PG-6

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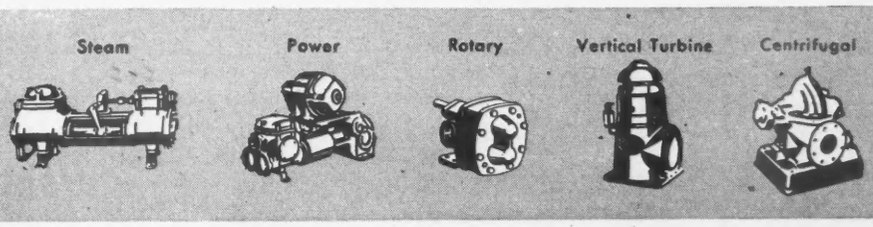

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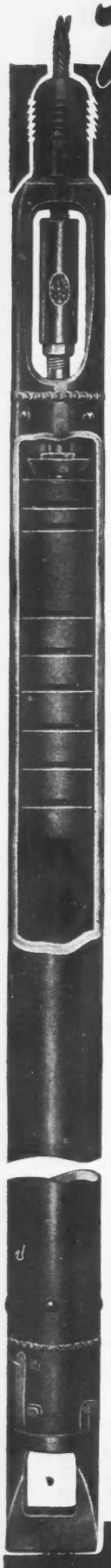

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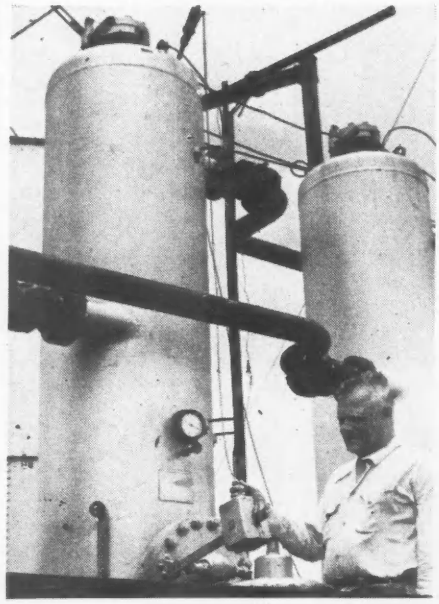
HOW TO—
Guide Boatmen

Access to wells and separator platforms located in large lakes, bays and open water is often impossible due to heavy fogs or rain. Condition of the water may be such that boats can travel, but it is a problem to locate the structure once the boat is in the area of the separator platform. Weather conditions have made it difficult to reach these platforms for several days, particularly when heavy fogs persist. Wind and waves



often prevent the pumper from making trips to these marine structures and there are times when the pumper must get to the separator platform even though there is a fog.

In order to save considerable boat time and expedite the trip, one marine operator installed a whistle device which serves to guide boatmen to the platform once they are in the area. The high pitch of this steam whistle, sounded at intervals, can be heard several thousand feet away in a fog. Pressure which accuates the steam whistle is gas from the well separators. The whistle is mounted on a short nipple welded into the top of the separator. Valve lever of the whistle is connected to the separator dump valve counterbalance arm by means of a metal chain. Length of the chain is so adjusted that every time the separator dumps fluid, the whistle blows a high-pitched note. Since the separator battery handles approximately 4000 barrels of fluid daily, the dump valve operates frequently. A back pressure of about 150 pounds is held on the separator.

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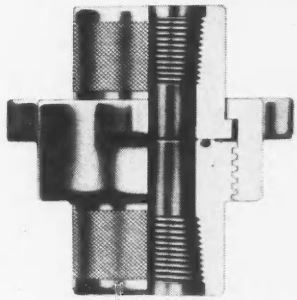

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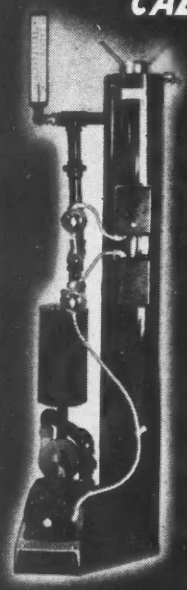

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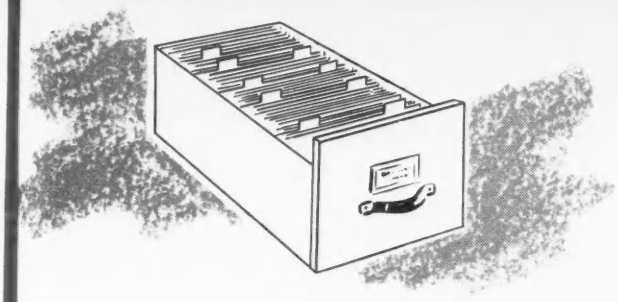

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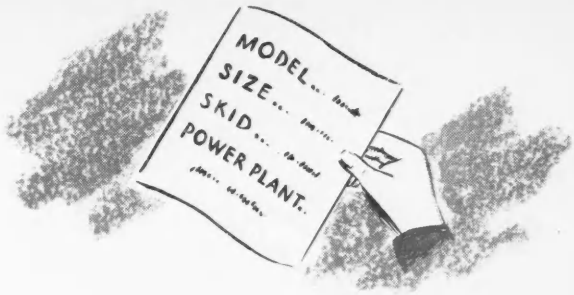
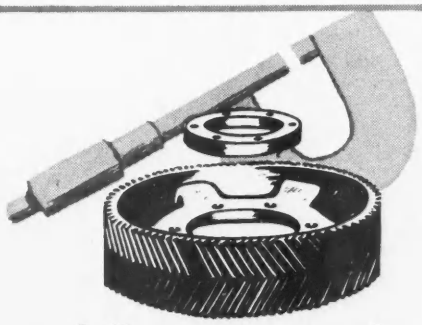


of all Gaso units



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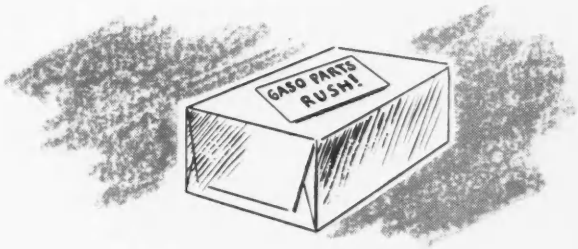

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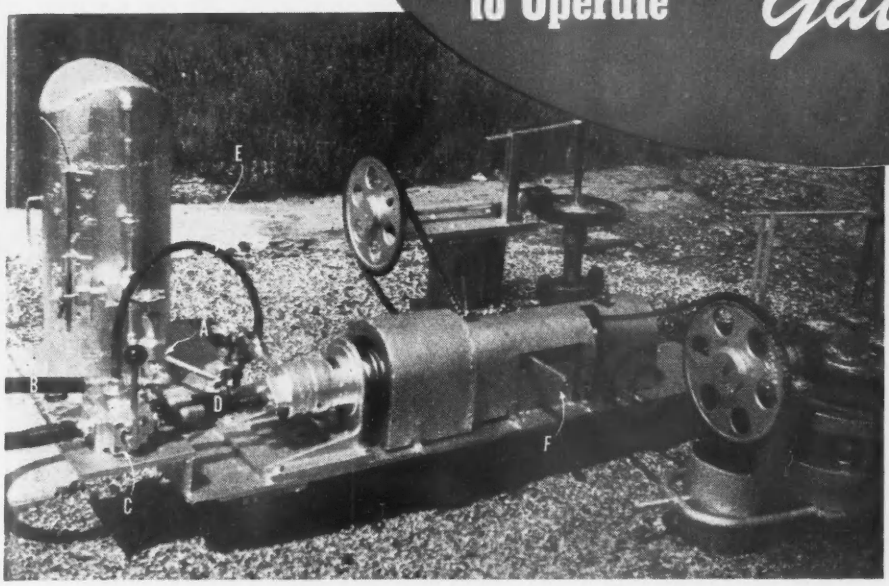
Utilizing Line Pressure to Operate Gate Valves



General view of hydraulic valve operating unit. Line pressure is taken through the one-fourth inch needle globe valve A, through the flexible line B to the four-way valve C. Lines D are either intake or exhaust for the motor, depending on the direction of rotation. Line E is the exhaust line from the motor to the sump pit. Opening the gate valve A, shifting the control lever of the four-way valve, and shifting the jaw coupling slide member F is all that is required to operate either of the ten-inch header gates shown.

THE AUTHOR describes an ingenious application of hydraulic power already present in a pipe line, bypassing a small amount of fluid through a unit which mechanically "wheels" gates otherwise requiring extra personnel and expenditure of considerable muscular effort.

By J. DELBERT JONES

Master Mechanic, Gulf Refining Company, Pipe Line Division

IN THE early days of the pipe line industry pipe and the attendant fittings were not of such size as to make the operation of gate valves in the manifolds a matter of great concern. Manifolds probably consisted of nothing more than gates to isolate the pumping equipment for repairs. Looping of lines, use of scrapers, batching of types of oil were things yet to come. Pressures were moderate enough to make the operation of the conventionally designed gate valve a subject to be given no further consideration other than to make sure that the operating personnel was familiar with the function of a particular gate or system of gates.

As size of the trunk line became larger and the use of the scraper was introduced, valve operation was extended, greater pressures increased the difficulty of manual operation of the valves in the system, bringing about improvements in design with respect to tightness and operation. The introduction of scraper traps to reduce line down-time to a minimum multiplied the number of gates in a given system as well as the number of times operated. To further complicate things, the use of loops, batching of different grades of oil and the like did not by any means simplify the problems of the operating personnel, but did make the problem of physically operating the gate valves in a given system a thing to be reckoned with. If the gate sizes are small and the times operated are infrequent, the normal station crew of an engineer and operator can handle the required gate valve operation without dificulty. As the number and size of gate valves increase manual operation takes the crew away from its regularly assigned tasks for too long a time. Frequently, older members of a station crew are not physically able to carry their part of the load in operating a number of gates, further adding to the difficulty of operation.

The above factors probably contributed their part to better design of valves and the introduction of anti-friction thrust bearings, gear heads and motor operated valves. This has greatly relieved valve operation in newer installations but has not materially affected the use of old valves in existing systems. Moreover, in the newer installations, the manifold system in a trunk line is intricate. The dispatcher's order to make a gate change to properly direct a movement of oil affects not one gate but several. To operate physically a number of modern designed gear-head gate valves of a large size requires extended effort on the part of the engineer and/or operator despite the newer designs and improvements.

Electric motor operated valves are available for such use. Many operators, however, object to the presence of either overhead or buried electric cabes in and near their manifold system because of the fire hazard. Air-operated motors present the problem of freezing in winter time, plus the need for lines to and from the gate system. The presence of a hydraulic pressure in the manifold system raised the possibility of using hydraulic motors to either open or close gate valves in any location. The use of such pressure does not materially raise the fire hazard above that already existing in the valve location. Outside power is not required. Freezing of equipment from weather conditions does not exist.

Oil used in operating the hydraulic motor is exhausted to the suction side of the station system and is not wasted but represents a small amount merely bypassed. In locations such as isolated scraper traps, the spent oil can either be piped to a small drum in the operators pick-up truck or wasted as desired. Investigating the use of such a type of motor, the Tulsa Pipe Line division of the Gulf Refining Company developed a design for a hydraulic motor operated valve mechanism that offers possibilities in either new or old installations.

Mechanism Design

The design consists primarily of the following component parts:

1. Four-way valve: This enables the operator to reverse the direction of rotation of the motor without disturbing any piping whatsoever, making it possible either to open or close a gate valve in the pipe line system by doing nothing more than shifting the operating lever on the control valve from forward to reverse and vice versa. The valve also provided means of speed control from one number of revolutions per minute to the maximum desired.

2. Hydraulic Motor: The motor used in the initial installation developed one horsepower at 1000 rpm, weighing less than 15 pounds. This proved of sufficient size and capacity to operate a ten-inch standard construction gate valve in a 800-pound line pressure system. The motor used required approximately six gallons of crude through the motor to open the ten-inch gate against the 800 pounds maximum pressure. Lower line pressures were sufficient to operate the hydraulic motor so that the gates operated by the hydraulic motor could be opened or closed with any combination of line pressures involved in the particular system.

3. Controlled torque clutch: This provided a safety factor in preventing a gate disc from being slammed closed too tight or opened with too much vigor with possible damage to the gate. The operator was also able to adjust each motor to the desired torque for the requirements of an individual gate valve. The clutch also acts as a flywheel to impart a high inertia impact to the jaw coupling.

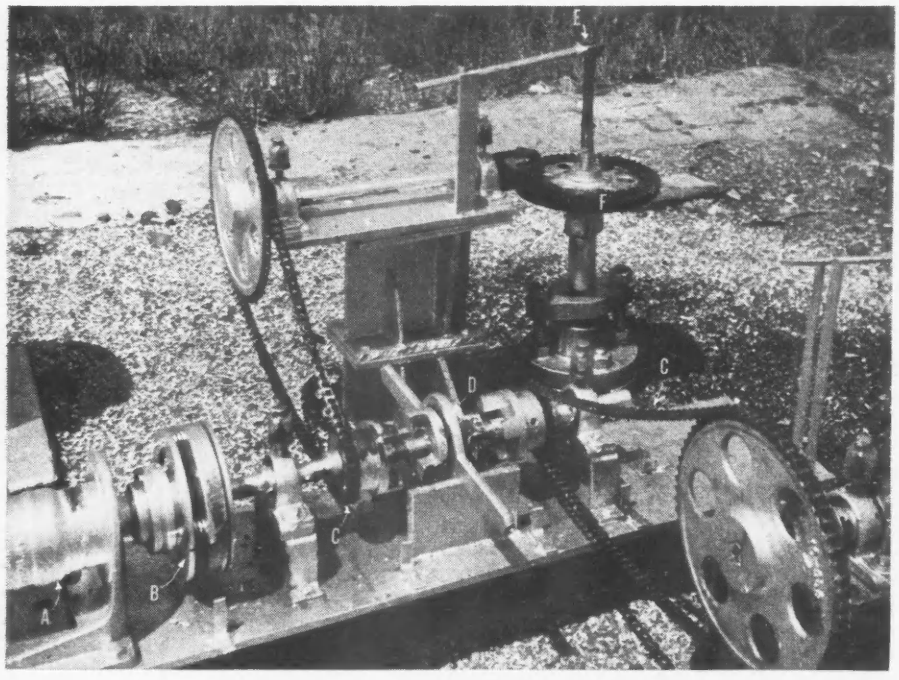
4. Jaw coupling: To enable the hydraulic motor to accelerate to an operating speed and at the same time to provide a slam-wheel effect, a three point jaw coupling was used. By varying the number of jaws and the diameter of the coupling, the amount of slam effect can be controlled. The operator is thereby able to "bump" a gate valve stem either to loosen or tighten, if so desired. Once the movement of the stem has started, the speed of the remainder of the operation is entirely under control of the operator. In the initial installation, one motor was used to operate two gate valves located approximately three feet apart. By providing one sliding member for two jaw couplings, shifting of the sliding member made it possible to operate either of two gates. Engaging one coupling automatically disengaged the other so that it was impossible to operate two gates simultaneously.

5. Chain drives and gear train: A chain drive was utilized to transmit the impact impulse of the motor to the gear train atop the valve proper, a positive transmission being considered more desirable than one that would tend to soften the impact impulse. The gear train ratio as well as the chain drive ratio is a variable factor that can be altered to suit either local conditions or size of motor and operating speeds desired.

6. Revolution counter: A simple revolution counter was installed on the gate valve stem to acquaint the operator with the position of the valve disc with respect to either the open or closed position. If desired, the operator can speed up the operation after the discs have been "cracked" and slow down again near the fully opened position, if time is a factor.

The photographs indicate the general arrangement of the initial installation. Flexible lines were used to connect the line pressure to and from the hydraulic motor to eliminate any trouble from distortion of stiff line connections. A set of gate valves that was very difficult to operate was deliberately selected in the initial test. In normal operation, four men and considerable time was required to complete one cycle of operation in the dispatching of a scraper. With the use of the hydraulic motor, the same operation can be carried on with very little physical exertion on the part of one man. The time element is negligible. A one-fourth inch needle globe valve was placed in the pressure line ahead of the motor to restrict the flow of oil to the hydraulic motor to provide additional safeguard and broaden the range of speed control of the four-way valve.

The application has many possibilities. By suitable arrangement of equipment one motor can be made to operate any number of valves. Should the type of crude oil be such that it in itself would not be amenable to hydraulic motor operation, hydraulic power could be provided by a remotely located motor driven pump to gain the advantages of hydraulic operation. Automatic operation can also be provided for by proper selection of valves and other accessories. By making the gate valve operation a one-man job, it is possible to operate a scraper schedule on a predetermined basis, rather than having to dispatch scrapers at a time when men are available to switch gates, other factors notwithstanding. This Gulf installation has attracted considerable attention and the idea already has been adopted by other pipe line companies.



View of mechanism with guards removed. The floating member of the jaw coupling D can be shifted along the shaft to engage the other half of the coupling and thus operate either gate.

A—Hydraulic motor.
B—Control torque clutch.
C—Chain drive.
D—Jaw coupling.
E—Revolution counter.
F—Gear train.

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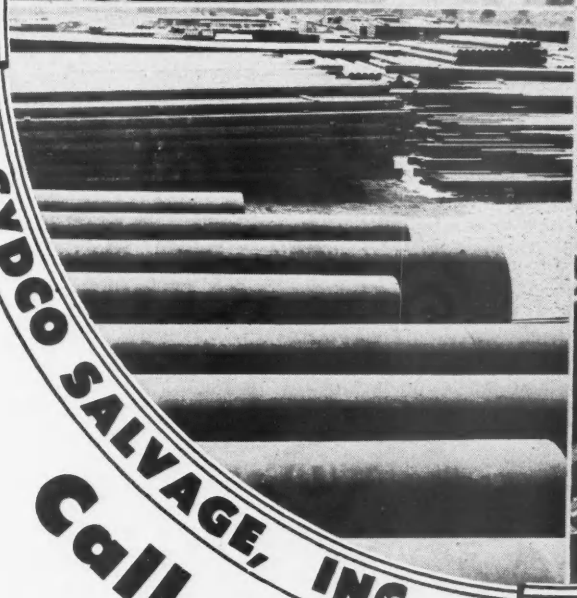

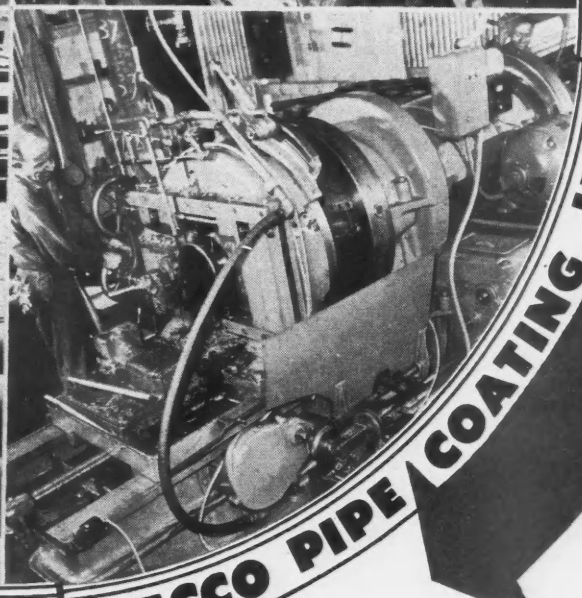

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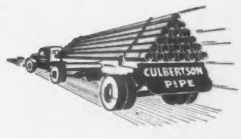

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Transcontinental Line Under Way

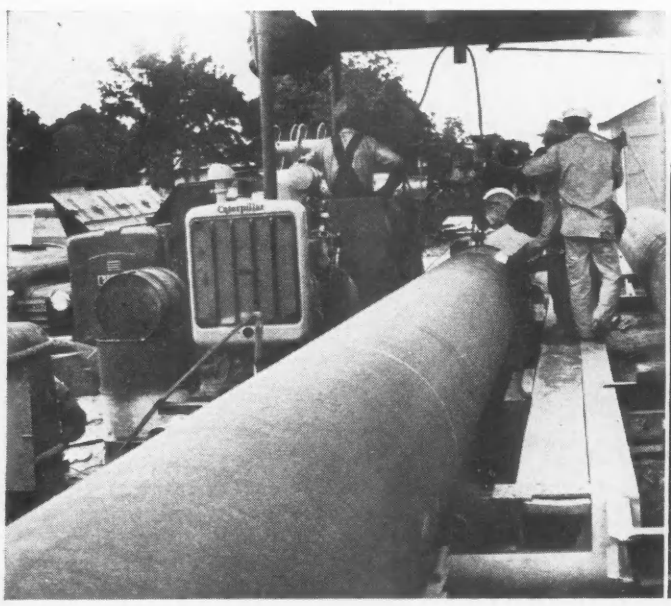
Watched by visiting pipeliners, officials of his own company, and a crowd estimated at 5000, President Claude A. Williams turns the first spadeful of earth to mark the beginning of the 1840-mile trench which Transcontinental Gas Transmission's new line will fill.

GROUND-BREAKING ceremonies for the 1840-mile main line section of Transcontinental Gas Transmission Company's 30-inch gas line near Laurel, Miss., were followed promptly by actual pipe laying. First dirt was turned by Transcontinental's president, Claude A. Williams, and even as he and Ray Fish, president of Fish Constructors, Inc., were introducing visiting pipe line notables, the first of the 48-inch, 8½-foot trench was cut through the site.

Pipe is being made up into field doubles, averaging 60 feet in length, and is cold bent to conform to trench contours. Use of the doubles cuts the field welding in half, and enables one-half of all welds in the line to be checked before being moved from the site of the doubling operation.

By 5 p.m. on the day of the ceremonies, approximately 600 feet, or ten of the field doubles, had been welded, doped, wrapped, laid in the trench, and backfilled.

The line, to cost $235 million, will have an ultimate capacity of 505 million cubic feet per day. Gas from the fields of Louisiana will be transported into New York City. The line is scheduled for completion early in 1951, but it is expected that partial throughput will have been achieved by September of 1950, or approximately 16 months after ground-breaking.



Thirty-foot mill joints are paired into field doubles in this welding and testing plant, reducing field welds to one-half the normal and simplifying weld inspection and testing.

The first 600 feet of 30-inch gas transmission line, with an eventual capacity of 505 million cubic feet per day, goes into the 48-inch, 8½-foot trench.

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- ☐ Oiling down lease roads
- ☐ Tank bottoms to slush pits for disposal
- ☐ Filling tank trucks with water for initial treaters, indirect heaters, radiators, etc.
- ☐ Transferring tanks (leaky tanks, bad oil; for repairs, cleaning, etc.
- ☐ Transferring salt water
- ☐ Cleaning up oil lease: line breaks, tank leakage
- ☐ Circulating tank bottoms through treaters
- ☐ Circulating bad tanks through treaters
- ☐ Pumping from tank or treater to slush pit
- ☐ Driving chemical feed pump
- ☐ Draining treater for cleaning
- ☐ Domestic service around lease houses
- ☐ Cleaning B.S.&W. from tanks (heavy)
- ☐ Cleaning B.S.&W. from tanks (light)

PIPELINE OPERATIONS AND MAINTENANCE

- ☐ Cleaning up oil lease
- ☐ Pumping out sumps
- ☐ Removing water from pump houses
- ☐ Dewatering for repairs
- ☐ Salvaging oil in event of line break
- ☐ Transferring tanks in case of leaks
- ☐ Gathering systems (lower pressures)

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- ☐ Dewatering
- ☐ Water supply to equipment
- ☐ Washing down equipment
- ☐ Pumping station foundations

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- ☐ Pumping cooling water
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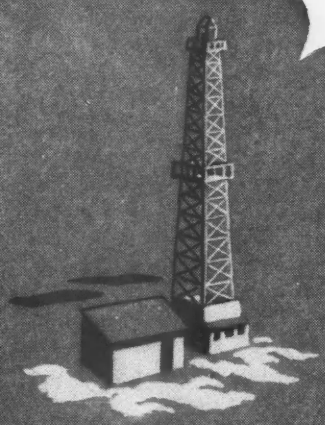

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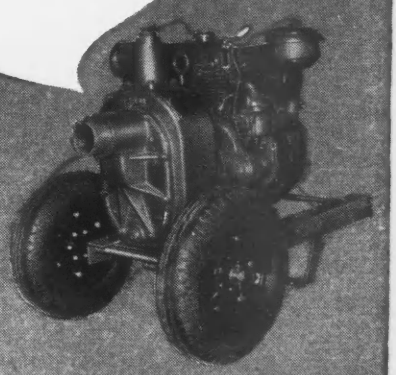

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Suspended Material in Crude Oil Streams

By J. E. GREEN, A. H. HALL and J. R. LUTTRELL

Shell Pipe Line Corporation

TO DETERMINE the quantity, particle size and composition of the suspended solid materials carried in oil streams — these solids being responsible for mechanical damage to volumeters and pipe line pumping equipment — samples were taken of various crudes and microscopic examination made of the solids recovered. The authors make no attempt to outline a cure for the difficulties incurred through suspended solids, but present in this paper, substantially as presented a Division of Transportation symposium on pipe lines during the 1948 annual meeting of the API, data bearing on the quantity and sizing of the particles which must be removed to eliminate wear other than that caused through corrosion phenomena.

THE principal cause of wear on closely fitted moving parts of equipment handling crude oil, neglecting direct effects of corrosion, is the grinding or abrasion of the solid matter entrained or suspended in the crude oil. High-speed centrifugal pumps handling oil containing suspended silica sand suffer rapid abrasion of impeller wear rings. Volumeters suffer slow destruction of precision bearings and close-clearance moving parts. The carefully finished surfaces in mechanical seals and on pump-shaft sleeves are damaged by extremely finely divided abrasive material, almost colloidal in size. Closely fitted parts in pumps and meters have failed because the designer relied on the pumped crude oil to provide adequate lubrication for bearing surfaces or overlooked the abrasive action at points of leakage. Two ways of eliminating the damage caused by the suspended abrasive material are:

1. Remove the suspended solids prior to handling.
2. Prevent the abrasive-laden liquid from entering the close-clearance parts of the equipment.

A combination of the two methods might prove more successful, but a discussion of that is not included in this paper.

Composition and Size of Suspended Solids

Suspended solid materials commonly found in the crude oil are silica or quartz sand, silt, iron oxides and sulfides, metallic pieces, crystalline salt, carbon, and sulfur. The sizes of the particles range from collidal to about 0.080 inch. Some chunks as large as 1½ inches in their greatest dimension have been found, but these usually consist of smaller particles bonded together.

Part of the solid matter is magnetic, indicating ferric oxide (Fe_2O_3). The ratio of the magnetic to non-magnetic material varies, with the pipe lines carrying the more corrosive oils usually having the highest percentage of magnetic material. A sample of such material was collected in a settling chamber from 700,000 barrels of mixed West Texas-New Mexico oil over a period of 60 days. It is classified in Table 1 according to particle size and whether magnetic or non-magnetic. For the total sample, 37 percent was magnetic and 63 percent was non-magnetic.

Silica or quartz sand, which is probably the worst abrasive causing equipment wear, was found to range in size from about 0.0002 inch to grains exceeding 0.040 inch in dimension. Figures 1 and 2 show silica or quartz particles taken from a West Texas crude-oil stream. Quartz is well-known as an abrasive, being rated seventh compared to tenth or hardest for diamond in the comparative hardness scale for mineral.

Silt (composed of earth, clay, and siliceous material) accounts for only a small part by weight of the solids. Although often found in large chunks, it is usually finely divided, and remains in suspension. Silt is probably the principal abrasive of precision-fitted elements, because it is most difficult to remove by settling, straining, or filtering. The hardness of the silt is indeterminate, but it is probably a fair abrasive.

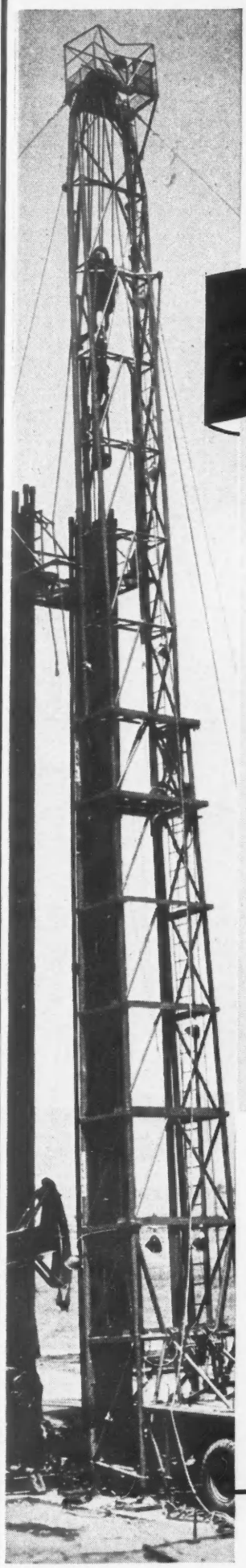
Corrosion Products

Corrosion products are mainly iron oxides and sulfides. Ferric oxide (FE_2O_3), a crystalline material, reddish brown to black in color, is abundant in the solid matter from most oil streams (see Figures 3, 4, 5, 6, and 7). Ferric oxide is formed by the oxidation of ferrous oxide and ferrous sulfide, and by the direct union of oxygen and iron, the latter reaction accelerated by the presence of salt water. The ferric-oxide particles are quite hard and, like silica, have a wide range of size.

Ferrous oxide (FeO), black in color, is unstable, readily oxidizing further to ferric oxide. A primary product in the rusting of iron, it is found principally

TABLE 1

	Mesh	Wire Diameter (Inches)	Opening (Inches)	Magnetic	Percent	Non-Magnetic	Percent
Retained on	60	0.0075	0.0092	5.0610	84.35	6.9561	67.02
Retained on	150	0.0026	0.0041	0.7536	12.52	2.3446	22.60
Retained on	250	0.0016	0.0024	0.1042	1.74	0.5372	5.17
Retained on	325	0.0014	0.0017	0.0596	0.99	0.3853	3.72
Retained on	400	0.0010	0.0015	0.0130	0.22	0.0841	0.81
Through	400	0.0010	0.0015	0.0109	0.18	0.0705	0.68



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gathering lines carrying extremely sour oil. When cleaning pipe line scraper traps and strainers in sour crude districts, care must be taken to prevent spontaneous combustion of the ferrous oxide. The material must be kept wet to prevent contact with air.

Ferrous sulfide (FeS), brown to black crystals, is formed by the action of corrosive sulfur compounds on iron and steel. It, too, is abundant in lines carrying extremely sour oil. This material is unstable when finely divided and, like ferrous oxide, will burn spontaneously on contact with air. Ferrous sulfide and ferrous and ferric oxides are much alike in color, and are usually mixed together when recovered from sour crude lines; thus they are hard to identify separately.

Few particles of steel are found in oil streams. They are mostly "spatters" from electric welding, spherical in shape, and protective-coated with iron oxide. Small steel borings or cuttings may appear—these also are coated with oxide or sulfide. Such particles are highly magnetic.

Crystalline salts are present in most crude oil containing connate water. The suspended water droplets may be a saturated solution at formation temperature; but, as the temperature is reduced and carbon dioxide is released, salt and lime crystals form inside the droplets. The crystals observed ranged in size from ultra-microscopic to about 0.0008 inch. If the water globules were to be evaporated, dry salt and lime crystals probably would remain in suspension; however, no oil-wet crystals were observed in this survey.

The particles of elemental carbon and insoluble asphaltic material, found only in settled water and sediment, were mostly colloidal in size. It is doubtful if such particles are abrasive.

Crystalline sulfur was found in small amounts. The largest crystal observed was approximately 0.008 inch in its greatest dimension. The origin of the elemental sulfur is probably the oxidation of hydrogen sulfide at low temperature or the oxidation of ferrous sulfide with insufficient oxygen.

Quantity of Suspended Solids

Suspended solids in crude oil comprise principally the granular materials from well-producing formations and the corrosion products formed by oxygen and sulfur compounds in contact with steel pipe, tanks, and other equipment. Minor sources of such solids are the "mud-plugs" used in pipe line repair work, and wind-blown sand which enters field tanks with faulty roofs.

The quantity of suspended matter in crude oil varies widely. That coming from the well formation depends on the compactness of the formation itself and on the production method and rate. The amount of scale from the pipe and tanks varies, in general, with the amount of oxygen and hydrogen sulfide in the oil and its connate water.

Table 2 shows the quantity of solids, expressed in pounds per 1000 barrels of oil, for each of the tests made. The average quantity for each type of crude oil sampled is given in the following tabulation:

Type of Oil	Where Sampled	Suspended Solids (Pounds Per 1000 Barrels)
Mixed West Texas-New Mexico* (6)	McCamey	0.2188
Mixed West Texas-New Mexico* (9)	Cushing	0.1155

TABLE 2
Suspended Solid Material Found in Various Lines

TYPE OF OIL	Sample No.	Date	Barrels of Oil Represented by Sample	Sample Size (Gallons)	Weight of Suspended Material (Grams)	Suspended Material (Pounds Per 1,000 Bbl.)
Mixed West Texas-New Mexico (Sampled McCamey Station)	1	3/10/47	4,860	146	0.5369	0.3410
	2	3/10/47	12,120	364	0.7133	0.1815
	3	3/10/47	19,000	567	1.2743	0.2090
	4	3/11/47	6,430	193	0.4660	0.2240
	5	3/11/47	5,800	174	0.3125	0.1665
	6	3/11/47	2,970	89	0.1837	0.1910
Average						0.2188
Mixed West Texas-New Mexico (Sampled Cushing Station)	1	9/30/46	182,000	1,020	0.2010	0.0182
	2	10/ 2/46	96,000	601	0.2430	0.0375
	3	10/ 3/46	40,000	282	0.0758	0.0249
	4	10/ 4/46	62,000	112	0.0868	0.0718
	5	10/ 7/46	130,000	245	0.5440	0.2060
	6	10/29/46	336,000	562	0.5425	0.0895
	7	10/31/46	96,000	351	0.8670	0.2290
	8	11/ 4/46	192,000	421	1.4222	0.3130
	9	3/ 4/47	90,000	270	0.1461	0.0504
Average						0.1155
Ector County, Texas (Sampled Barnsley Station)	1	3/12/47	1,090	126	1.1255	0.8275
	2	3/12/47	1,470	170	1.1705	0.6380
	3	3/12/47	1,910	210	1.2891	0.5690
	4	3/ 3/47	1,125	130	1.0172	0.7260
	5	3/13/47	364	42	0.1817	0.4000
	6	3/13/47	43	5	0.0795	1.1475
Average						0.7180
South Oklahoma (Sampled Cushing Station)	1	2/25/47	2,180	262	0.1846	0.0652
Kansas (Sampled Cushing Station)	1*	10/ 2/44	19,950	13	0.4551	3.1600
	2	10/ 3/44	9,270	27	0.1372	0.4725
	3	10/ 7/44	2,375	45	0.0387	0.0798
	4	10/10/44	66	8	0.0486	0.5640
	5	10/16/44	182	22	0.0180	0.0758
	6	10/19/44	215	27	0.0035	0.0120
	7	10/20/44	192	24	0.1739	0.6700
	8	2/ 6/47	3,320	420	0.9689	0.2135
Average						0.2982
North Oklahoma (Sampled Cushing Station)	1	2/24/47	3,320	420	0.3884	0.0859

* Sample No. 1 not included in average.

FIGURE 1. Sample from West Texas sour oil line: retained on 60-mesh (0.0092 inch). Majority of particles are silica sand resulting from a "mud-plug." Large "tear drop" is sulfide or welding "sputter." Grids: 0.020 inch and 0.004 inch.

FIGURE 2. Sample from West Texas stream: passed 60-mesh; retained on 150-mesh (0.0041 inch). Practically all sand particles are due to "mud-plug." Note relatively small number of sharp corners on particles.

FIGURE 3. Sample of solids from a Kansas stream: retained on 60-mesh (0.0092 inch) screen. Grids: 0.020 inch and 0.004 inch. The shell-like material is principally iron oxide.

FIGURE 4. Material from a Kansas stream: particles passed 60-mesh (0.0092 inch); retained on 150-mesh (0.0041 inch). Grids: 0.020 inch and 0.004 inch. Most of the particles were iron oxide and sulfide. One large sulfur crystal was present.

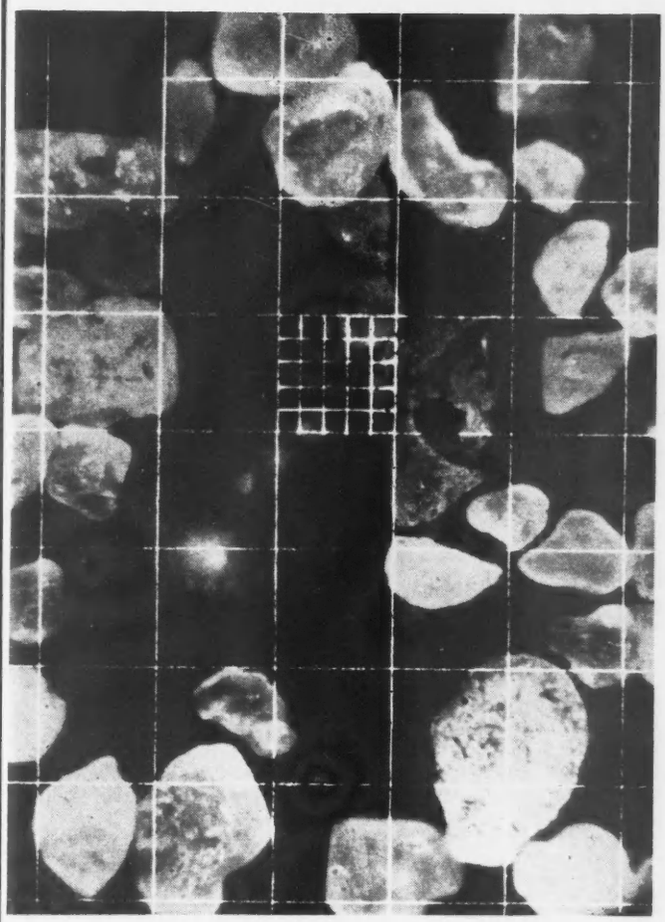


FIGURE 1

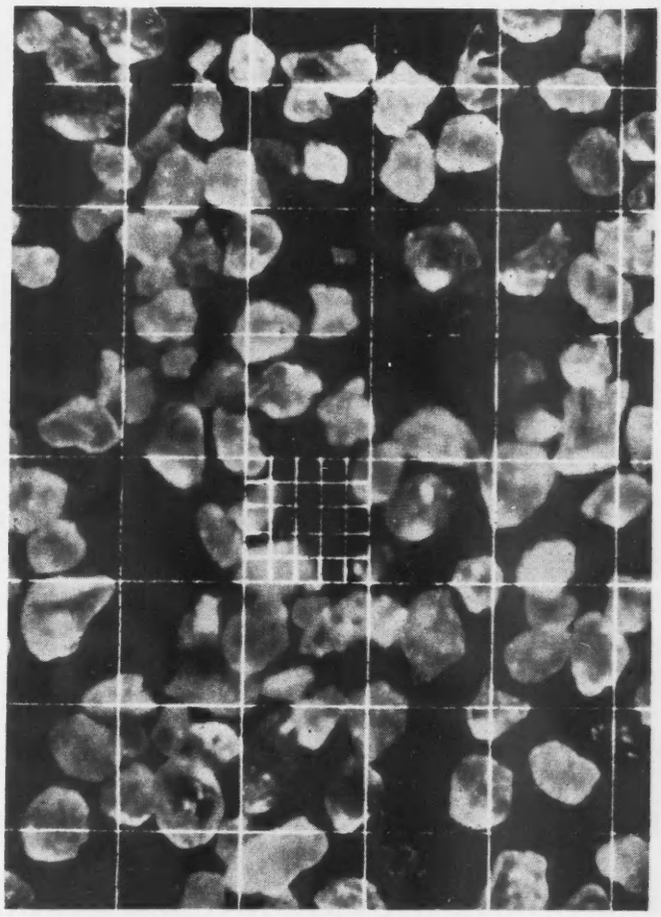
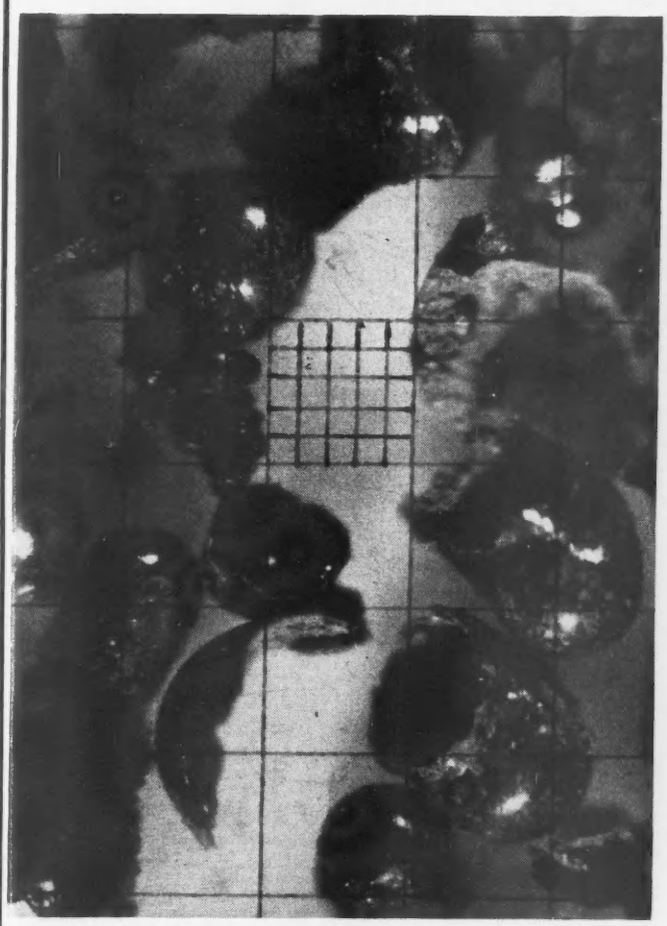


FIGURE 2



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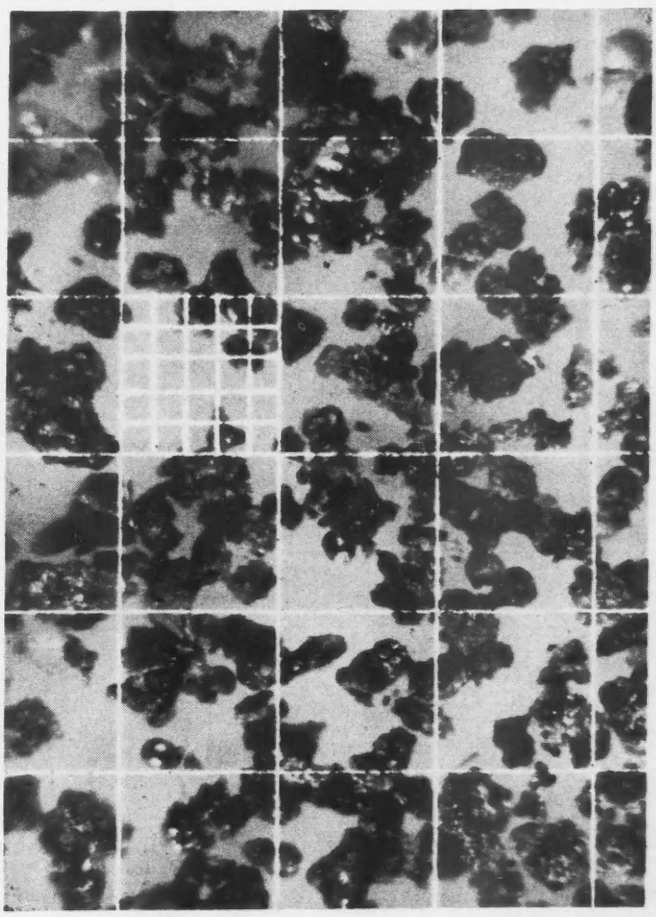

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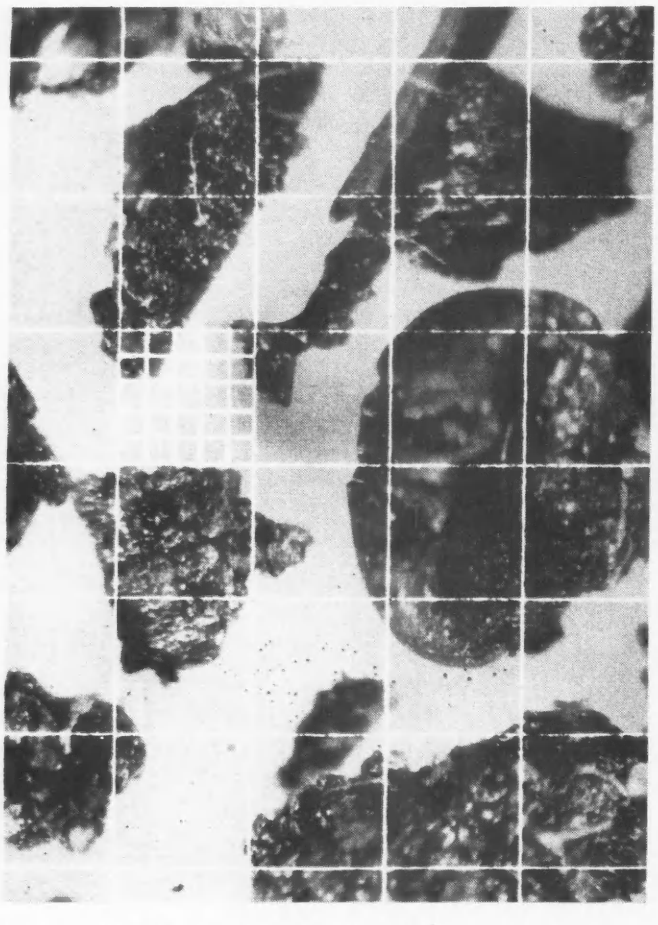

FIGURE 5. Sample from West Texas-New Mexico sour oil stream: retained on 60-mesh (0.0092 inch) screen. Pieces were predominantly ferrous oxide and sulfide. Grids: 0.020 inch and 0.004 inch.

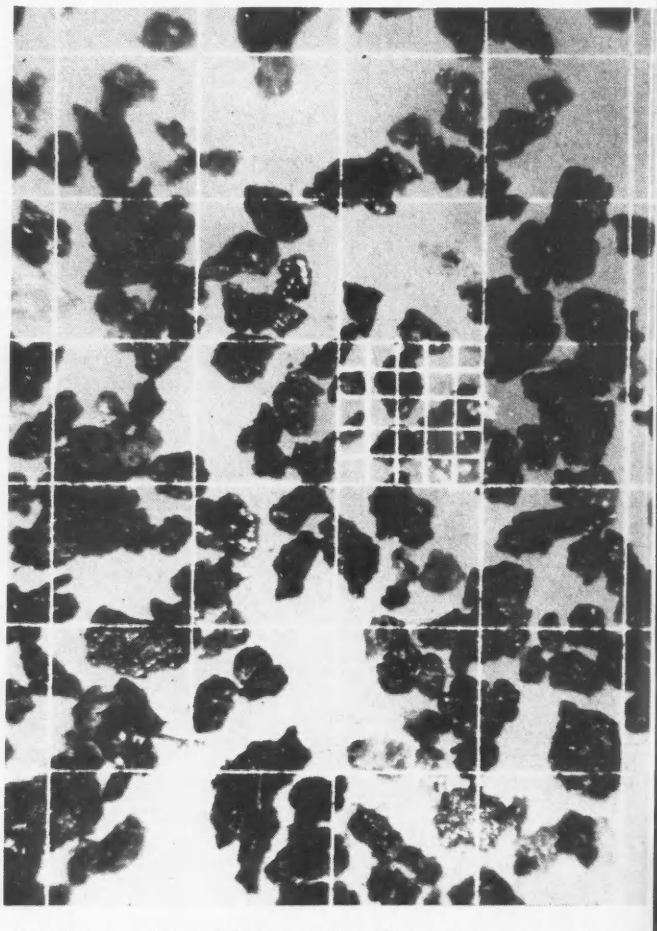

FIGURE 6. Sample from West Texas-New Mexico stream: passed 60-mesh (0.0092 inch); retained on 150-mesh (0.0041 inch). Particles: iron-oxide-sulfide. A large piece of red iron oxide is under small grid; particle of clear quartz is in space above small grid.

Ector County (6)*	Barnsley	0.7180
South Oklahoma (1)	Cushing	0.0652
Kansas (8)	Cushing	0.2982
North Oklahoma (1)	Cushing	0.0859

* Samples taken prior to stream entering storage tanks. Numbers of samples taken is shown in parentheses.

As seen in Table 2, Kansas sample No. 1 showed 3.16 pounds of solids per 1000 barrels of oil. This sample was taken from a six-inch line in Kansas crude service while the line was being reconditioned. In moving and cleaning the pipe, scale was dislodged from the inside pipe wall. Corroboration of this statement is found in the fact that 67 percent of the recovered solids was iron oxide. Such high abrasive content, although occurring infrequently, seriously damages meters and pumps.

Removing Solids by Settling

Solids may be removed from oil by settling, if they are allowed to stand in a tank. This is indicated by the smaller quantity of suspended solids in the mixed West Texas-New Mexico stream at Cushing than at McCamey. This settling process may be quite slow. Below the temperature where wax starts to crystallize from the oil, the wax may deposit on the solid particles that are not water-wet—thus increasing the particle's diameter and decreasing its apparent density. The "wax point" of each of the following types of crude oil is:

	Degrees F.
Mixed West Texas-New Mexico	60
East Texas	77
North Oklahoma	55
South Oklahoma	45
Kansas	55

Sampling

A survey of several crude-oil streams was made to determine the quantities and characteristics of the suspended solids. Three methods of sampling were used:

1. "Slip-stream."
2. Settling chamber.
3. Thiefing of storage tanks.

Only the first two were used for quantitative measurements.

In the "slip-stream" method, shown diagrammatically in Figure 8, a small oil stream was taken from the pipe line by a perforated nipple extending diametrically through the pipe to assure a representative sample. The "slip-stream" was run through a 325-mesh strainer and then pumped through a meter back into the pipe line with a small pump. The strainer was flushed periodically to prevent clogging. Sampling by this method is not entirely satisfactory, as only the particles exceeding 0.0017 inch (325-mesh) are retained.

The solids obtained by the "slip-stream" method were recovered in about one gallon of the crude oil which was used to flush the 325-mesh strainer. This gallon of oil was heated slightly to dissolve all wax and then run through a 400-mesh sieve which collected the solids. The material was washed thoroughly with xylol and acetone and then dried. Care was taken to minimize the oxidation of the material during and following the drying process.

Settling Chamber

The settling chamber, through which an entire pipeline stream was run, was used to collect some of the samples. By this method particles smaller than 325-mesh were retained. The sizes of smallest observed particles thus collected were 0.0002 inch (five microns) as determined microscopically.

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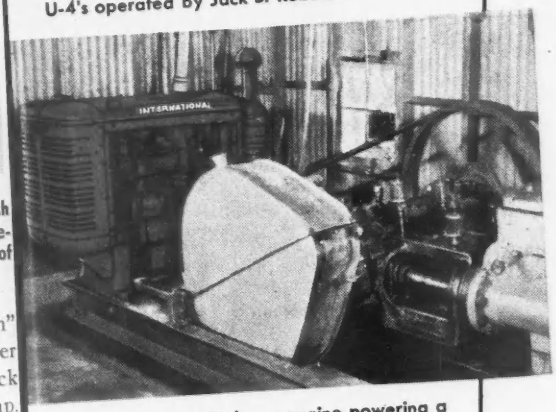
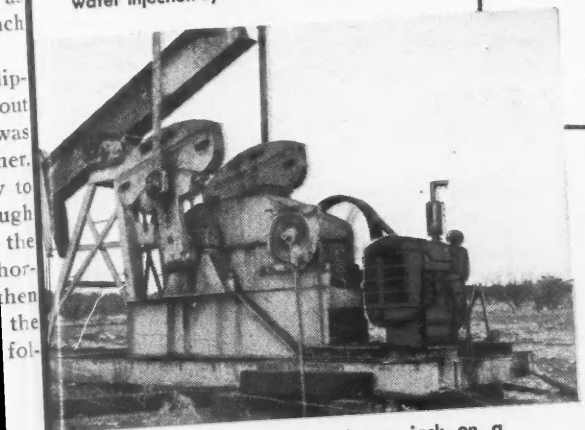


An International U-6 gas engine powering a 3½" x 10" double-acting pump, forcing water into a header and injection lines on a water injection system.



An International U-4 powering a jack on a 6,012-ft. oil well on the A. E. Smith lease in Stonewall County, Texas, for Jack B. Robert.

JACK B. ROBERT
BRECKENRIDGE, TEXAS

February 7, 1949

H. R. Carlson
Asst. Dist. Manager Industrial
International Harvester Company
1809 South Lamar Street
Dallas, Texas

Dear Sir:

Since 1942 we have been using several U-4 International power units, as well as several competitive units. In the latter part of 1947 we found that our operations would require the purchase of several new power units. At that time we decided to standardize on one type of power unit. In order to decide which power unit would be the best, we talked to the pumpers using the various units and also determined from our records the maintenance cost of the various units. The following record of one of our U-4's is typical of why we decided to standardize on International Power Units:

> A U-4 International on a No. 8 Jensen Pumping Unit, pumping two 2500 ft. wells 12 hours per day, ran 4 years without a major overhaul, has run one year since then, and is still running fine. The maintenance cost over the five-year period was an average of $81.66 per year including the major overhaul cost (replacing sleeves, pistons, and all bearings).

We are now using two U-6's, ten U-4's, and one U-2, and plan to use more as our operations require them.

Yours very truly,

Thomas A. Ford

THOMAS A. FORD
Production Supt.
Jack B. Robert
Independent Oil Producer

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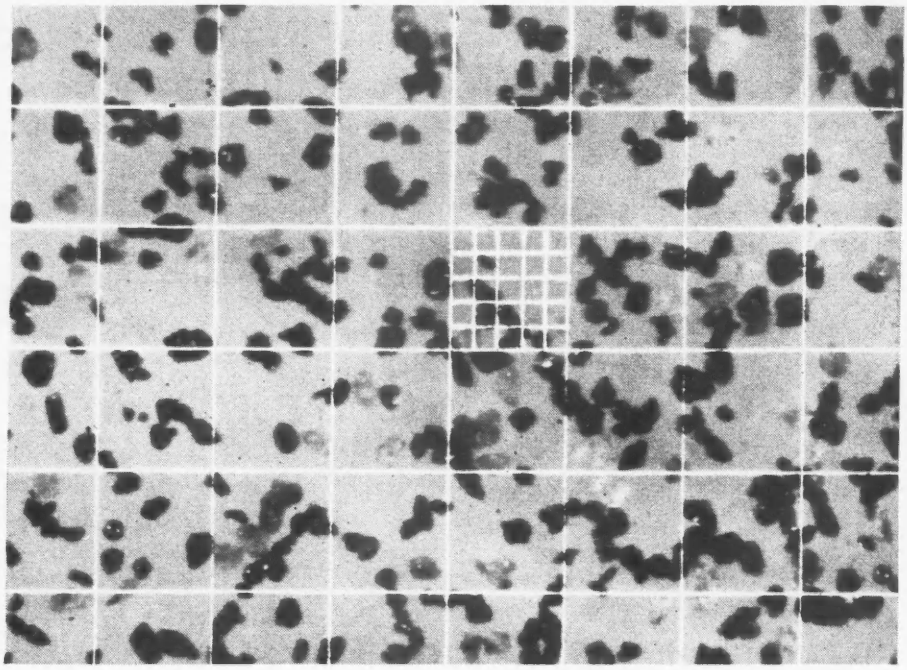


FIGURE 7. Material taken from West Texas-New Mexico stream by settling chamber. Particles passed 400-mesh (0.0015 inch). Grids: 0.0025 inch and 0.0005 inch iron sulfides and oxides with quartz. Note spherical pieces.

from storage tanks in West Texas crude-oil service, was examined for qualitative purposes only—quantitative data being impossible because of the inability to determine total quantity of water and sediment in the tank.

The material taken from the settling chamber and the water-and-sediment samples was put into a small beaker which was suspended in an extraction flask. The reflux of extracting solvent, xylol, and acetone flowed into the beaker, washing the oil and water from the solid matter and then overflowing into the flask. The sample was removed from the extractor when the overflowing solvent was clear. The excess solvent was then evaporated, leaving the clean solid material.

Discussion of Samples

Photomicrographs of the solids from some of the crude-oil streams are included to show more clearly the nature of the suspended material. The material in Figure 7 was taken from the settling chamber; the other samples for the photomicrographs were collected by the "slip-stream" method on a 325-mesh wire cloth. With few exceptions, the particles in the "slip-stream" samples exceed 0.0017 inch. The suspended material was divided into five ranges to facilitate the micrography:

1. Retained on 60-mesh (0.0092 inch)
2. Passed 60-mesh, retained on 150-mesh (0.0041 inch)
3. Passed 150-mesh, retained on 250-mesh (0.0024 inch)
4. Passed 250-mesh (0.0024 inch)
5. Passed 400-mesh (0.0015 inch)

Figures 1 and 2 show silica or quartz sand recovered from the West Texas stream at Cushing. The abundance of sand was due to a "mud-plug." Some good examples of iron-oxide-sulfide scale and silica particles are seen in Figure 2. The photomicrographs were prepared with a superimposed grid system to permit measurement. In Figure 7 the large grid divisions are 0.0025 inch (63 microns), and the small divisions are 0.0005 inch (13 microns). The grids in the other micrographs are 0.020 inch (504 microns) and 0.004 inch (102 microns).

The preparation of samples and the photography were done in Shell Pipe Line Corporation's laboratory at Cushing, Okla.

Sample from Kansas Stream

Photomicrographs of material from a Kansas crude stream are Figures 3 and 4.

Most of the material found in the Kansas oil was iron oxide and sulfide, principally the former. The hollow spherical shells seen in Figure 1 are iron oxide that was probably formed on the surface of suspended brine droplets. The Kansas sample contained very little silica.

Sample from Extremely Sour Crude Line

Figures 5, 6, and 7 show material recovered from the mixed West Texas-New Mexico stream at Cushing. Most of the particles are almost black in color, and 35 percent by weight are magnetic. Even the magnetic material contained sulfur, indicating that the particles are a mixture of iron oxides and ferrous-sulfide crystals. Very irregular pieces of silica are present in each size range of West Texas-New Mexico stream sample.

The material shown in Figure 7 represents the finest particles recovered from the settling tank. The particles are those which passed a 400-mesh sieve, and are predominantly iron oxide-sulfide. Good examples of silica and spherical sulfide particles are seen.

Conclusion

This study was made to determine the amount and characteristics of the suspended solids in crude-oil streams which damage volumeters and pipeline pumping equipment. It was not intended to propose or suggest a "cure for this ailment."

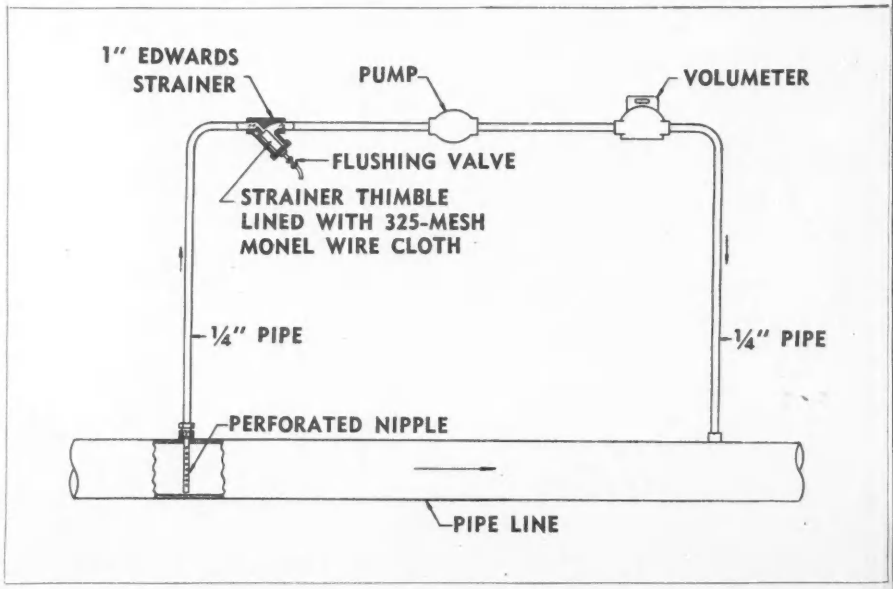
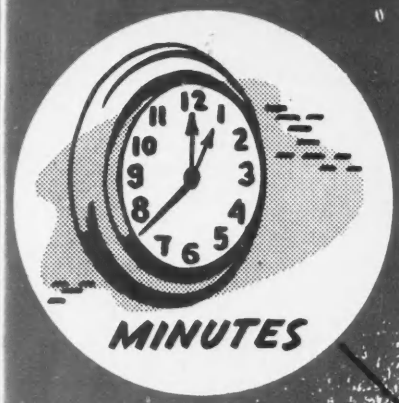


FIGURE 8. Layout for slip-stream sampling as used in collection of samples described.



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PIPE LINE *Construction*

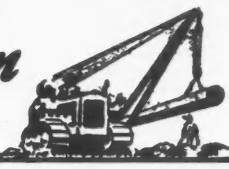
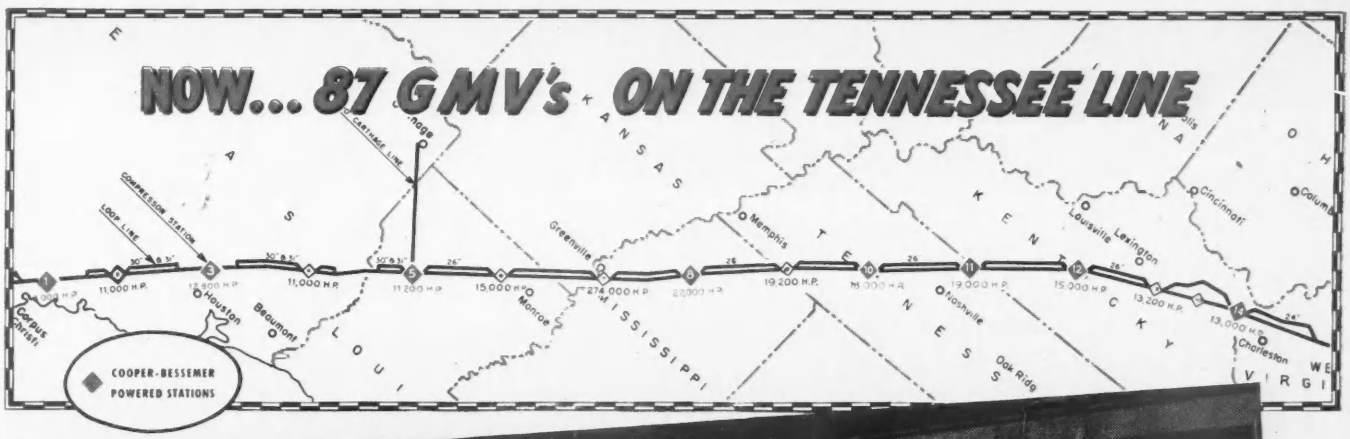


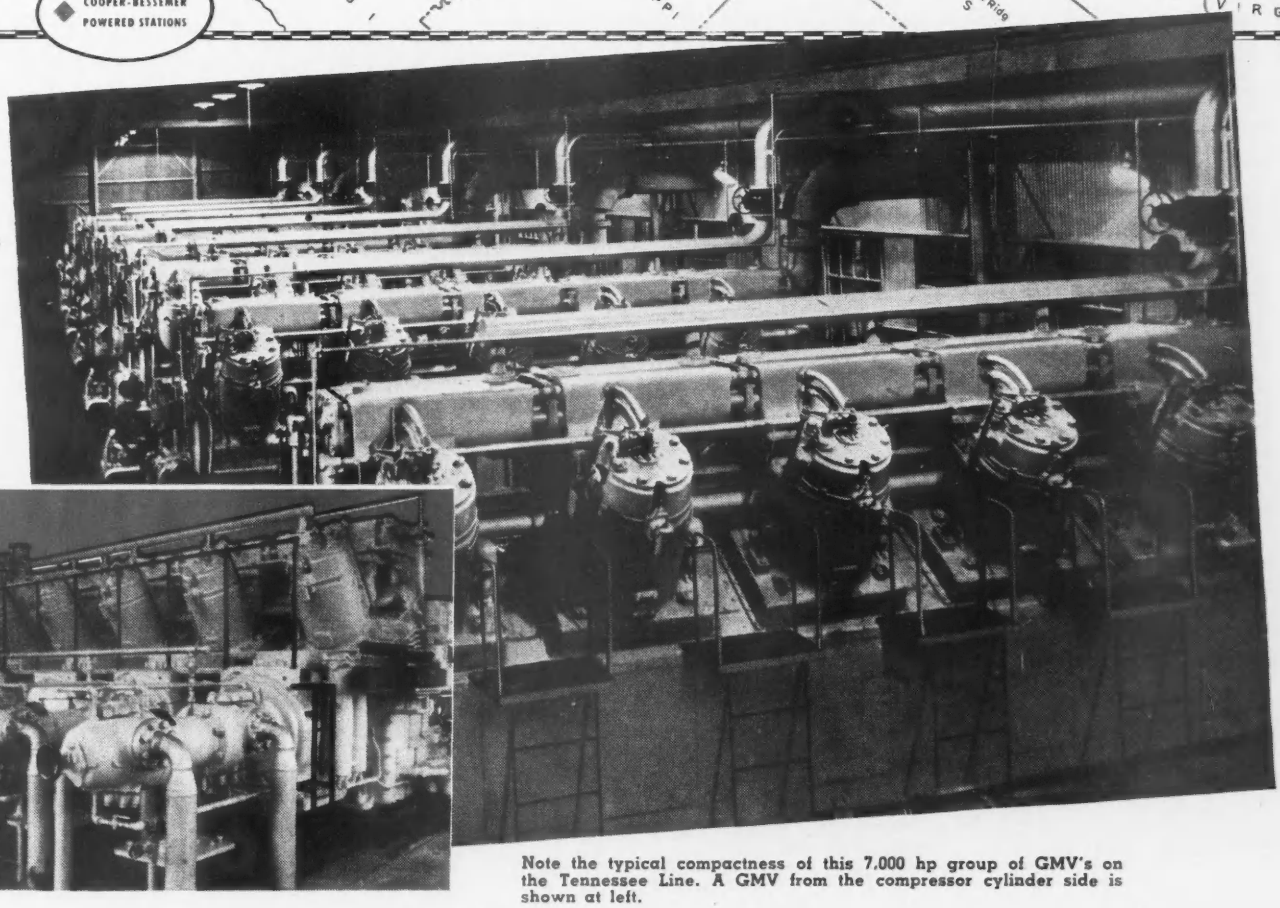
Table includes projects planned, contracts awarded, and spreads or entire projects completed since the last issue of WORLD OIL.

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Barrels Cu. Ft.)	REMARKS
CRUDE OIL LINES					
The Buckeye Pipe Line Company.	Lima to Toledo, Ohio	82	22	.....	This carrier parallels an existing line. Anderson Bros. Corp., Houston, is scheduled to complete by end of July.
	Speedway City, Ind., to Ohio Oil's proposed terminal near Lima, Ohio	140	8	.....	H. L. Gentry Construction Co., Jackson, Mich., has started work on 6-in. and will start on 8-in. August 1.
	Lawrenceville to Buckeye's sta. at Robinson, Ill.	21	6	.....	
Magnolia Pipe Line Company....	Cross Roads field & Betenbaugh areas, Lea Co., N.M. to Stanolind's Cap Rock-Slaughter 8-in. line	15	6	.....	This field discharge line is proposed.
Pasotex Pipe Line Company.....	No. Snyder fld., Scurry Co. to Colorado Sta. on Basin System, West Texas	22	6	.....	This discharge line and a gathering system was completed by Morrison Construction Co., Inc., Austin.
Phillips Pipe Line Company.. ...	Goldsmith fld., Ector Co., W. Texas to Borger refinery, Texas Panhandle	289	12	38,000	Completed in June by Morrison Construction Co., Inc. However, no crude to be moved via this line for indefinite period.
Plains Pipe Line Company.....	Mush Creek fld., Weston Co. to Lance Creek fld., Wyo.	50	8	13,400	Line will connect with Rocky Mt. P. L. Co's. carrier. Hardwick Constr. Co., Billings, Mont., is scheduled to complete in August.
Richfield Oil Corporation.....	Cuyama Valley fld. to San Joaquin-Maricopa line	30	8	.....	Completed in July by Pacific Pipe Line & Engineers, Ltd., Los Angeles, and replaces temporary 6-in. line of invasion pipe.
Shell Pipe Line Corporation.....	Hobbs to Basin P. L. System, Jal, N. Mex.	41	14	65,000	Line will augment deliveries to Basin System and is to be completed Aug. 1, by Latex Construction Co., Houston.
Shell Pipe Line Corp. and The Texas P. L. Co. (Ozark System)	Cushing, Okla. to Wood River, Illinois	439	22	186,000	Ozark System of Jal to Wood river line. Completed and dedicated.
Simrall Pipe Line Corporation...	Pentwater fld., Oceana Co. to Pipe Line at Woodville, Mich.	32 10	6 4	.....	Will be completed by Aug. 1 by Somerville Construction Company, Ada, Michigan.
Sun Pipe Line Company.....	Seabreeze Sta., near Beaumont to Pt. Neches Terminal	43	8 & 10	.....	Being constructed by Sheppard-Geiger Constr. Co., Corpus Christi.
The Texas P. L. Co., Shell P. L. Corp., Empire P. L. Co., Sinclair P. L. Co. (Basin System)..	Jal, N. M. to Midland, West Texas Midland to Wichita Falls, North Texas Wichita Falls to Cushing, Oklahoma	87 257 173	20 22 24	 167,000	Basin System of Jal to Wood River line. This system connects with the Ozark System at Cushing to complete the line. Entire 1000-mile project is now complete and is largest crude line ever built by private capital.
The Texas Pipe Line Company...	Wood River to Patoka, Illinois	55	22	84,000	Extension to Jal to Wood River line. Sheehan Pipe Line Construction Co., Tulsa, has completed.
	Upham Sta., Jack Co. to Chico Sta., Wise Co., N. Texas	36	8	.....	Under construction by Latex Construction Co.
Texas-New Mexico Pipe Line Co.	New pump sta., S. W. Borden Co. to Colorado Sta., Basin System, Scurry Co., West Texas	40	10	.....	Proposed line to deliver crude from Vealmoor and Good flds., and new Sinclair discovery to the Basin Pipe Line System.
	Discharge lines from three flds. to new pump sta	29	6	.....	
PRODUCTS LINE					
Salt Lake Pipe Line Company...	Standard of Cal's Salt Lake refinery to Boise, Idaho	320	8	.....	Call for bids made July 1. Cost will be $6 million with one station at refinery. May later be extended to Spokane, Wash. which would raise cost to $12 million. To be completed by end of 1949.
NATURAL GAS LINES					
Alabama-Tennessee Natural Gas Company	TGT line at Selmer, Tenn. to Tuscumbia, Alabama	75	10	.....	Lehman-Hoge & Scott, Harlingen, Texas, started construction July 15.
The American Gas Transit Co...	New Orleans, La., vicinity to Chicago, Illinois	1000	30	500 mln.	This is a $300 million project and is reported to be backed by British money. Materials, gas supplies, and right of-way are now being obtained.
Arkansas-Louisiana Gas Company	Waskon fld., East Texas, gathering system	12	3 & 8	.....	To be constructed by Wood Engineering & Construction Company, Arp, Texas.
Cabot Carbon Company.....	Vicinity of Odessa, West Texas	26	10	.....	McVean & Roberts Pipe Line Construction Co., Odessa, started construction in July.
Carthage Hydrocol, Inc.....	San Salvador fld., Hidalgo Co. to Synthetic gasoline plant, Brownsville, S. W. Texas	63	12, 14, 16	.....	This job was started in July by H. B. Zackry Co., San Antonio.
Central Kentucky Natural Gas	Loop from Menifee to Mt. Sterling, Kentucky TGT'S line to Menifee	23 2⅛	....	....	FPC approval granted. Certificate includes 6 additional compressor stations. Project to cost $1,643,200.
Interstate Natural Gas Company.	West of Baton Rouge, Louisiana	29	16, 20, 22	.....	Latex Construction Co. started in July.
Jersey Central Power & Light Co.	TETCO's Big Inch at Bound Brook, to Co's gas mfg. plant, Long Branch, N. J.	39½	10	.....	Made application to FPC.

TABLE CONTINUED ON PAGE 211

NOW... 87 GMV's ON THE TENNESSEE LINE





Note the typical compactness of this 7,000 hp group of GMV's on the Tennessee Line. A GMV from the compressor cylinder side is shown at left.

The story of the Tennessee Gas Transmission Company's big line is one of continuous growth from its beginning in 1944. Present capacity is 600 million cubic feet of gas a day. This year further expansion will add another 60 million cubic feet daily.

The line's engine-driven compressors now total 215,400 hp. Well over half, 119,000 hp, is furnished by Cooper-Bessemer units. Of these, 87 are modern 1000 hp V-angles . . . GMV's. Still more GMV's are to be added during the year.

On this and other lines GMV performance has proved a point of major importance to compressor users . . . that despite money-saving compactness, GMV's are truly rugged units, with exceptional resistance to wear and freedom from trouble. It adds up to compressor service at the lowest of low cost.

You'll be money ahead if *your* plans call for Cooper-Bessemer V-angles. They are built in three types from 200 to 2400 bhp.

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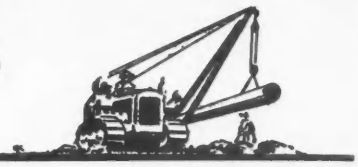
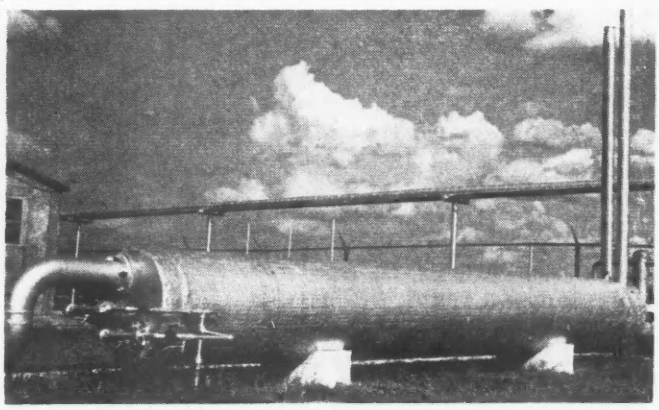
PIPE LINE HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Construct Temporary Gas Line Heater



It was necessary in winter to heat temporarily a six-inch line that brought gas from a nearby field into a booster station where the gas was added to the main system. By elevating the temperature slightly, the formation of hydrates in the line could be prevented on the upstream side of the line carrying gas to the dehydration unit.

This relatively small heating job was accomplished by building a heater around the line where hot water provided the heat to elevate the gas temperature above the dew point. The heater itself is nothing more that a joint of 24-inch casing which has been sealed at both ends, except for packed openings through which the gas line and fire tubes traverse.

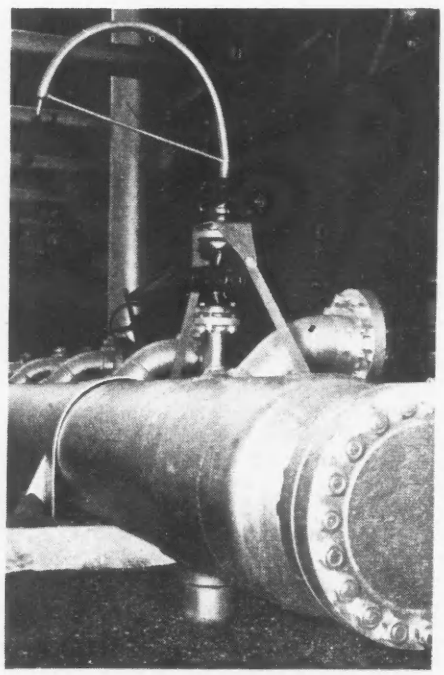
The six-inch gas line was fitted with ells so the line was elevated off the ground to a height which would permit the heater to be supported several inches off the ground by concrete foundations. The gas line was located near the upper side of the longitudinal heater so that maximum transfer of heat would occur. Two longitudinal fire tubes were added to the heater near the bottom. These tubes were of four-inch pipe which had been welded to the sealed end and equipped with stacks at the opposite end. Standard gas burners were mounted at the near end, the fuel gas being furnished through a station gas line.

A collar was welded to the top side of the heater at the far end to permit the addition of water as evaporation lowered the water level. This opening also permitted the escape of steam to eliminate any pressure accumulating inside the heater. To provide a maximum of heat transfer by this type unit and prevent any heat loss, the complete heater was covered with asbestos held in place by chicken wire.

HOW TO—Recover Oil from Compressor Engine

Compressors of 1000 horsepower require several hundred gallons of lubricating oil for their continuous operation. This oil, which serves to lubricate and cool the engine, is a special fluid that is continually being filtered. Some of it will pass the rings in the compressors, and this oil passed into the discharge line of a large gas booster station will represent a sizeable volume at the end of several days' operation.

In order to recover oil from the discharge line, one gas transmission company installed a drain device on the discharge header as shown. The drain is fitted onto the 24-inch header paralelling the cooling towers where the gas is cooled prior to entering the main transmission line. The 24-inch header slopes gently toward the flanged end at the right, so that any lubricating oil will accumulate in this end. A six-inch pot was welded to the bottom of the header. It is a bull plug screwed into a collar which has been welded to the larger pipe.



A section of two-inch pipe extends through the header down into the six-inch pot. It is welded at the top and fitted with adequate flange connections for a dual plug valve assemblage. The first high-pressure plug valve is firmly anchored to the header by means of strap pieces which have been welded to each side of the connection to the large pipe. A smaller valve above it permits the operator to carefully adjust the flow of oil through the drain line which is semi-circular in shape, and into an oil container.

The station engineer drains the oil from this header periodically and places it back into the lubricating oil filtering system of the large engines where it is reconditioned for reuse. This simple device has saved many gallons of valuable lubricating oil that would otherwise have contaminated the main line.

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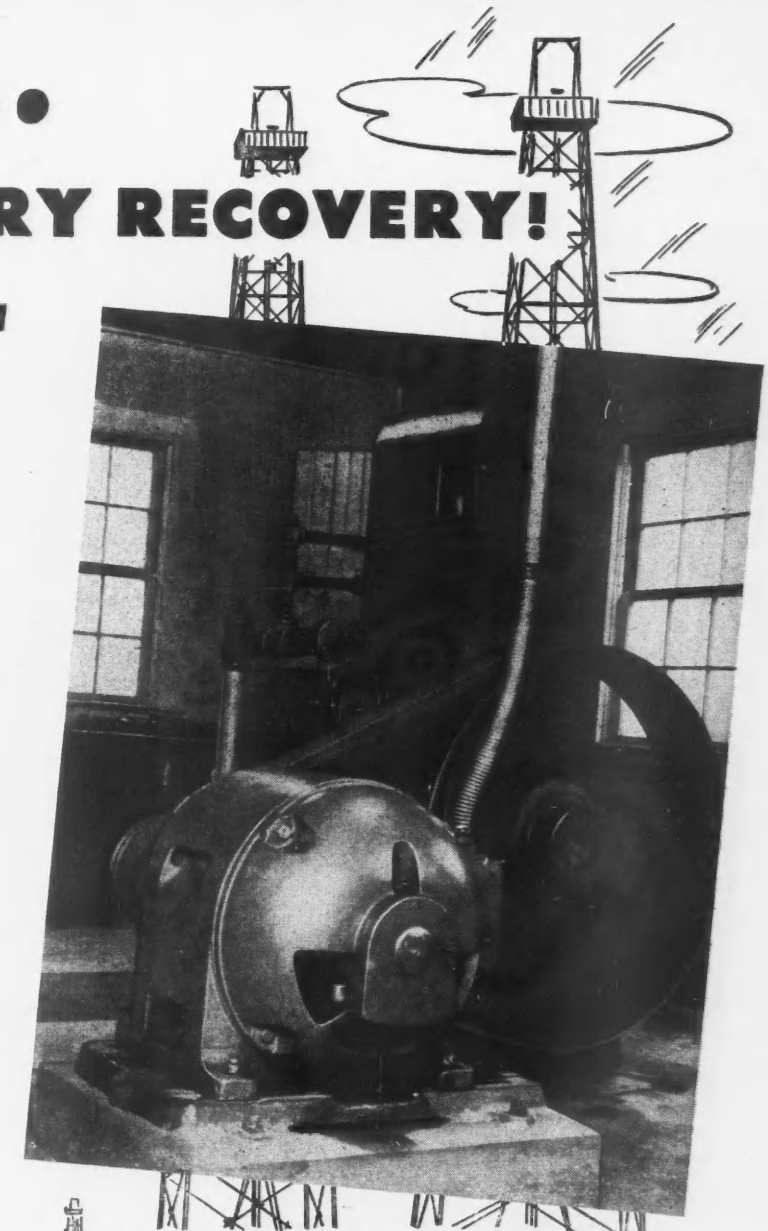

A 2x4 Worthington Variflo Triplex Pump used in secondary recovery (water flooding) of oil from the ground.

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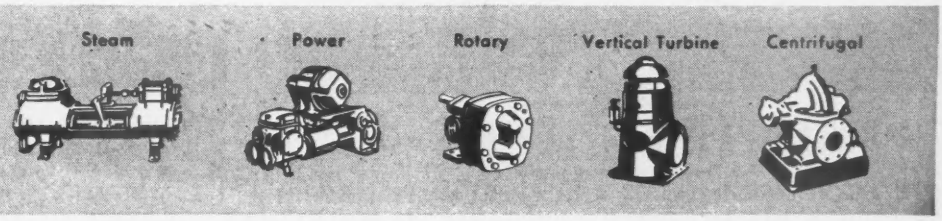
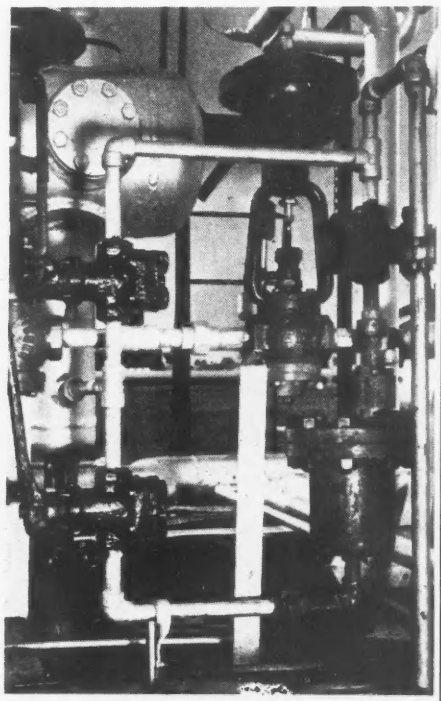


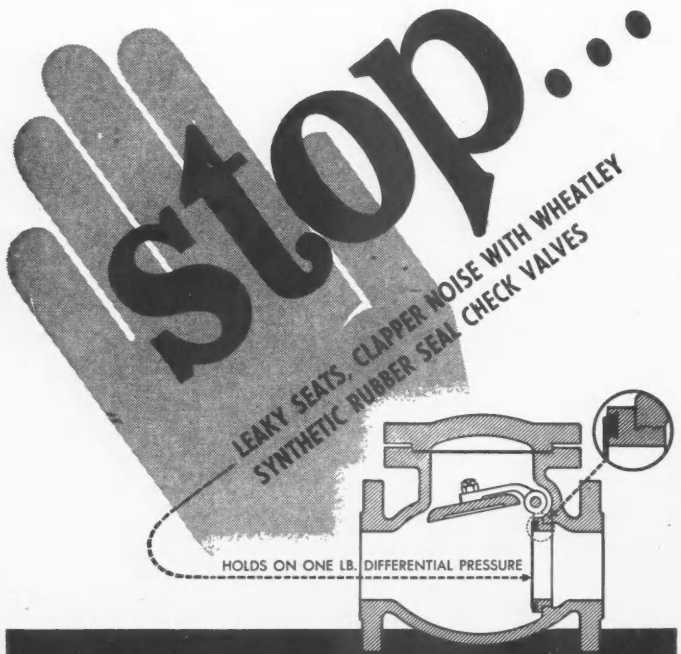
HOW TO—Drain Liquids from Scrubber



Removing liquids from a scrubber section in a dehydration unit can be accomplished two ways: manually and automatically. The piping arrangement illustrated is that of a gas scrubber that is designed for manual removal of condensate or water and for automatic dumping of fluids in the scrubber by means of a steam trap utilized for this job.

The scrubber is the horizontal pressure vessel at upper left fitted with the vertical drip leg. One and one-half-inch pipe was welded to the lower end of this leg so that fluid which collects in the drip can be drained off. The piping and valve on the upper half of the rectangular arrangement is used for manual operation. The valve below the tee on the line connecting to the drip leg is normally open since it starts the flow through the automatic section of the system. The bottom half of the piping system consists of a plug valve on each side of the steam trap which has been mounted in the drain system at such a height, in relation to the drip leg, that it will open when sufficient fluids fill its float chamber. Pressure in the scrubber forces the fluids through the dump system.

The discharged condensates and/or water are removed through a two-inch line which dumps into a waste tank. In normal operation, both valves on either side of the steam trap are left open, while the one valve on the manual line is closed. As fluids accumulate in the drip leg, they flow by gravity down into the steam trap until sufficient volume causes the trap to dump through the discharge line. If it is necessary to replace or repair the automatic dump device, the manual control valve can be used to remove the liquids from the scrubber.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HOLDS ON ONE LB. DIFFERENTIAL PRESSURE

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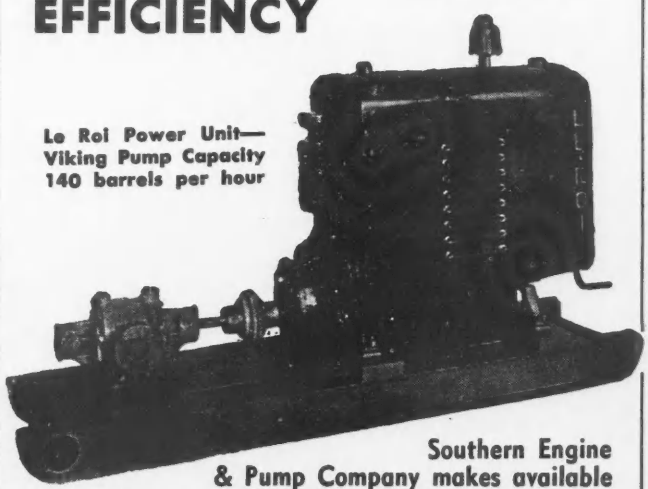

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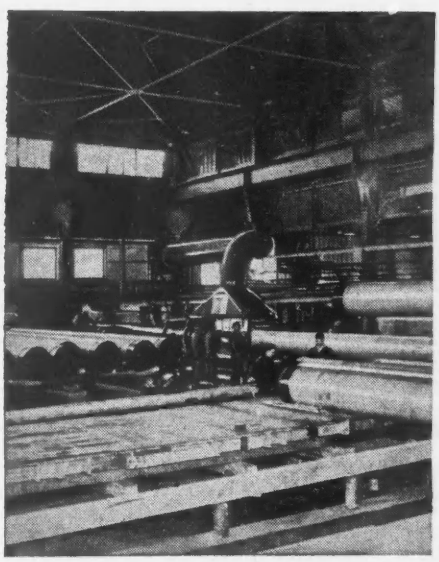

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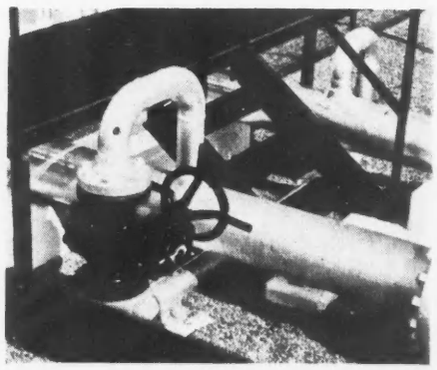
Barrett*

*Reg. U. S. Pat. Off.

HOW TO—
Bypass Discharge

It is occasionally necessary to idle compressors for an extended period to break them in after an overhaul prior to placing full line load on them. In such a case, the discharge line must be connected to the suction line in order that the gas can be circulated at relatively low pressures. Both intake and discharge lines are blocked off from the discharge and suction headers by high-pressure plug valves.

A simplified bypass arrangement which is unaffected by line vibration or expansion and contraction is illustrated. It consists of two risers that have been heavily welded to the top of both lines and equipped with ells so that the line is completely reversed and passes beneath the two main lines. One wing of the bypass is equipped with a plug valve to control the flow of gas through the line during such occasions or to completely block off the bypass during normal pumping operations. When the bypass functions, the engines and compressors can idle at whatever speed is desired until they are ready to handle full line load.



STRIP MAPS
for pipe line location

Edgar Tobin Aerial Surveys - with $7,500,000 invested in completed aerial maps - is an organization of more than 300 specialists, prepared to supply strip maps for pipe line location with maximum speed - at minimum cost. Photographic and regional base maps are immediately available for over 500,000 square miles of territory. County ownership maps comprising 268,250 square miles have been completed.

We have made right-of-way strip maps for the following companies:

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Big Inch Pipe Line*
Little Inch Pipe Line*
American Tel. and Tel. Co.
S. W. Bell Telephone Co.
Tennessee Gas Pipe Line Co.
Phillips Pipe Line Co.
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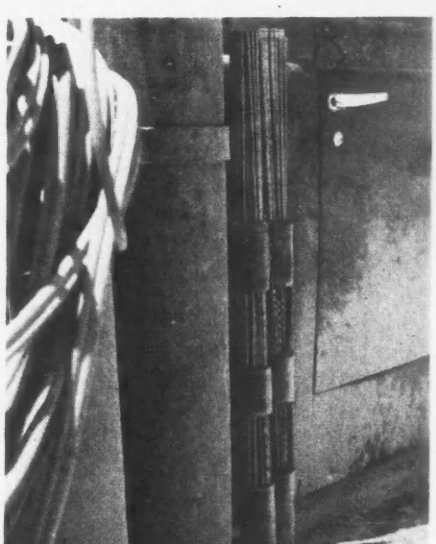
HOW TO—
Rack Welding Rods

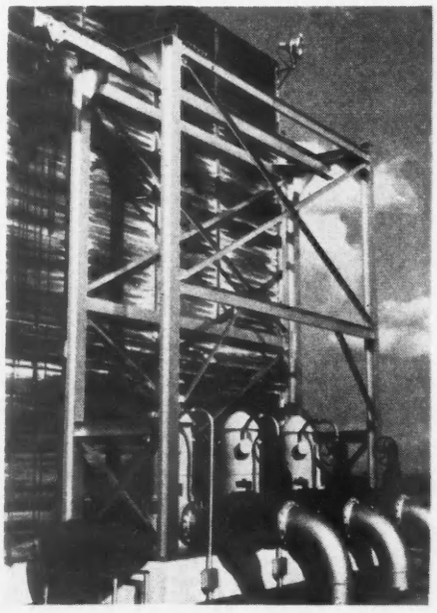


The practice of using one or several short pieces of tubing or two-inch pipe for storage of welding or brazing rod on field welding trucks is fairly common, but the pipe line welder of one company found it more desirable to cut windows in the sides of the containers in order that short pieces of rod could be stored for future use. Without windows in the tubes, unused short pieces of rod usually were tossed aside or thrown into a catch-all container, either of which resulted in a certain amount of waste or inconvenience.

If odd pieces of rod are placed in the

ordinary pipe container, they are difficult to see, let alone recover easily. With the cut-away container, short lengths of rod can be replaced in the appropriate container, and later, as easily taken out when needed.

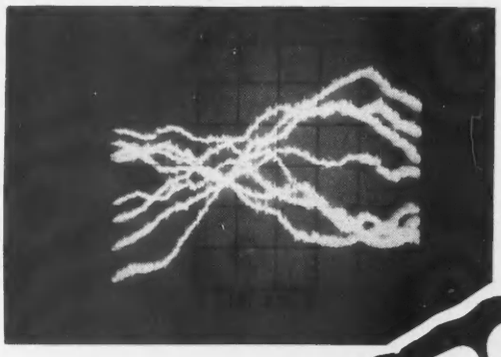
HOW TO—
Tend Water Pumps



The three vertical centrifugal pumps shown continually circulate water which flows over heater exchanger sections in this cooling tower. There are three separate ponds which provide the necessary flexibility of operations for this booster station's cooling requirements. By placing these pumps side by side in a common concrete foundation, a structural steel framework could be added to simplify repair and replacement of impellers or other parts located in the ten feet suction head barrel section.

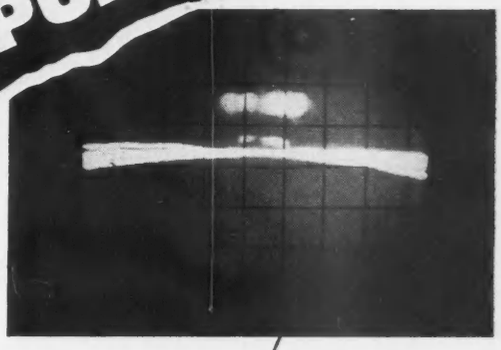
This structural steel frame is supported by four six-inch I-beams which are of sufficient strength to hold all three pumps. The frame is cross-braced to add rigidity. A center beam was attached to the two end cross pieces to accommodate a movable chain hoist. This beam extended over one end about six feet so that a complete pump unit could be raised from its foundation and loaded onto a truck with a minimum of lost time due to setting up lifting and loading equipment.

Design of the structure is such that it does not interfere with normal cooling tower construction or operation.



BEFORE INSTALLATION OF ACCUMULATOR
Horizontal graduations equal 50 psi and full sweep equals 0.3 seconds. Without accumulator the maximum pressure swing of the surging fluid is 350 psi.

HOW TO IRON OUT PUMP PULSATIONS



AFTER INSTALLATION OF ACCUMULATOR
Same installation with accumulator in system, the maximum pressure swing was reduced to 50 psi.

Pressure surges and pump pulsations are the two most common causes of pipe lines and hydraulic system failures. Surges and pulsations, however, can be greatly minimized or eliminated by installing a Greer Accumulator in the system. A simple "T" connection is all that is necessary to install it in any existing or newly designed circuit.

The "Before" and "After" photographs above give vivid proof of the effect of accumulators in hydraulic systems. A hydrauliscope and camera attachment were used to photograph the surges and pulsations of an actual pumping circuit. The "Before" picture shows the high degree of pulsations in the line not using an accumulator. The "After" picture shows how these surges and pulsations were effectively ironed out and virtually eliminated by the use of an accumulator.

Similar tests can be performed in your own system to demonstrate the effectiveness of a Greer Accumulator.

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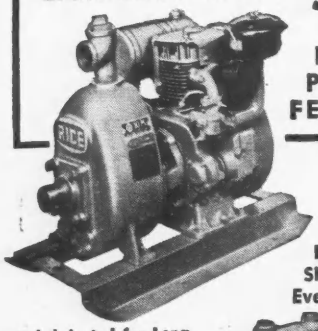

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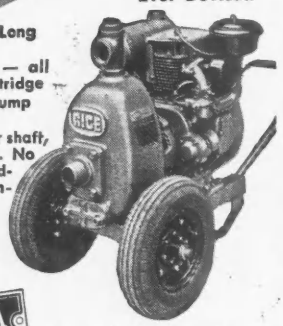

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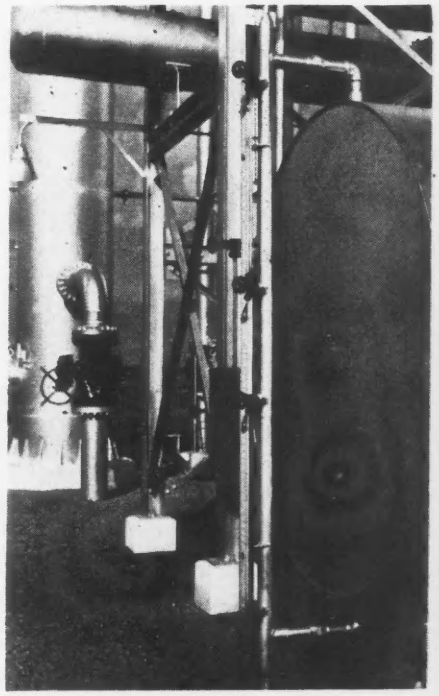
HOW TO—Add Gauge Glasses to Tank

An improvement over the normal method of attaching gauge glasses to any liquid vessel, be it cylindrical in shape or a circular tank, is that of measuring the supply of absorption oil in a storage tank. This oil is used in a battery of gas scrubbers to remove any condensate or oil which may be entrained in the gas.

Instead of drilling holes into the tank to attach the gauge glass connections, this method utilizes an external pipe connected to the top and bottom of the tank. Only two larger holes are required. A coupling is welded to the top and bottom hole and pipe fittings added to support the external piece of two-inch pipe. Two unions at either end make it an easy task of removing one gauge glass section and replacing it with a new one in the event the glass requires cleaning or replacing.

The vertical pipe is sealed at both ends, but is equalized by the connections to the tank. Three gauge glasses are used, two of which have been added to the pipe on the near side, while a third was added to cover the center section on the far side of the vertical pipe, and at 90 degrees to the other two gauge glasses. This spread permits a calibrated gauge stick to be mounted on the vertical pipe between the gauges so that an operator can easily determine at a glance the amount of scrubber oil contained in the tank.



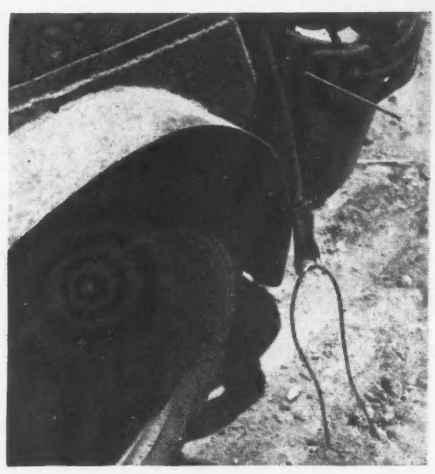
This method of adding gauge glasses to a tank facilitates welding the connections to either end of the glass fittings, in addition to minimizing the number of holes which must be cut into the tank.

HOW TO—Make Welding Ground Lead

To speed up operations in the construction of small diameter pipe lines and gathering lines, considerable time can be saved if the work end of the ground cable is equipped with a hairpin-shaped device which can be slipped over to provide contact with the pipe.

The hairpin is made of a length of ordinary iron welding rod of approximately one-fourth inch diameter. Easily bent to accommodate the particular size of pipe being welded, the hairpin is quickly forced over the pipe and as easily removed or dragged along the pipe to the next weld. It will withstand rough usage, and does not interfere with the coiling and transporting of the cable when the welding unit is moved.

An advantage of the device is that it provides more than a single point contact. If, through repeated use, the inner loop which normally would clamp the pipe snugly, should open up or expand somewhat, the weight of the cable will provide at least a two point contact.



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CONSTRUCTION OF the TAPline poses many problems because of its remote location and the character of the terrain. The accompanying article is a digest of a paper by S. P. Johnson at the Semi-Annual meeting in San Francisco of the American Society of Mechanical Engineers.

Engineering and Design of the Trans-Arabian Pipe Line

—All photos courtesy Trans-Arabian Pipe Line Company.

By S. P. JOHNSON
Engineer, Standard Oil Company of California

THE main problem of construction which distinguishes the Trans-Arabian pipe line from a similar project in the U. S. is the remote location and the large supporting organization required to back up the actual construction staff, although a few of the engineering problems are somewhat unusual.

The pipe line was first considered several years before the war. Serious thought of immediate construction started in 1943 when the U. S. government considered such a line a war measure. Original plans were tentative as to terminus of the line, Haifa and points in Egypt having been considered as possibilities. The presently surveyed distance on the route from Eastern Arabia to Sidon is 1067½ statute miles.

When the line was proposed the largest diameter seamless pipe available in the U. S. was 24-inch, and for that reason such a size was tentatively selected, with a capacity of 300,000 barrels per day also tentatively decided upon, largely because this is about the maximum throughput for 24-inch pipe without excessive pumping costs, and partly because oil production was estimated to be on that order by the time the line was constructed. The proposal that the government build the line was given up in 1944 when it seemed that the war would be over in Europe before the project could be completed.

Preliminary engineering investigation was authorized by The Texas Company and Standard Oil Company of California, then equal partners in Arabian-American Oil Company, and after a reconnaissance at the end of 1944 a route was recommended which is approximately the one along which the line is being built.

With the close of the war the same considerations that prompted the original proposal continued to urge construction of the line by private industry. Against the 1067½-mile length of the line was compared the tanker haul of 3167 nautical miles or 3650 statute miles around the Arabian Peninsula and through the Suez Canal to Port Said. It was estimated that 62 tankers of the T-2 type would be needed to handle the 300,000 barrels a day around the sea route. The tankers were not then available and their construction would require not only more than the actual tonnage of steel needed for the line, but much more fabrication work.

With a re-examination of the design after the war it was clear that for a nominal average rate of 300,000 barrels daily the 24-inch pipe was too small for best economy and a thin-wall pipe of approximately 30-inch diameter would be preferable. Procurement of pipe was difficult and the designers had to be guided by what was available, but the pipe being used is satisfactory. It is being manufactured at Maywood, Calif., from plate rolled at Geneva, Utah. Half the pipe is 30 inches and half 31 inches in diameter and most of it has a nominal wall thickness of one-fourth inch. The steel is medium carbon, medium high-manganese material. Specifications call for maximum of 0.30 percent carbon and from .85 to 1.25 percent manganese.

When the plate is planed, rolled and welded it runs about one-half inch undersize in diameter. After fabrication it is expanded in a heavy steel die under hydraulic pressure to full size. This cold work makes a significant increase in tensile strength, especially in a circumferential direction, amounting to a gain in from 12,000 to 20,000 pounds per square inch in yield strength, and about one-half as much in the axial direction. This work also results in an increase in ultimate strength in the circumferential direction by as much as 3000 to 7000 pounds per square inch.

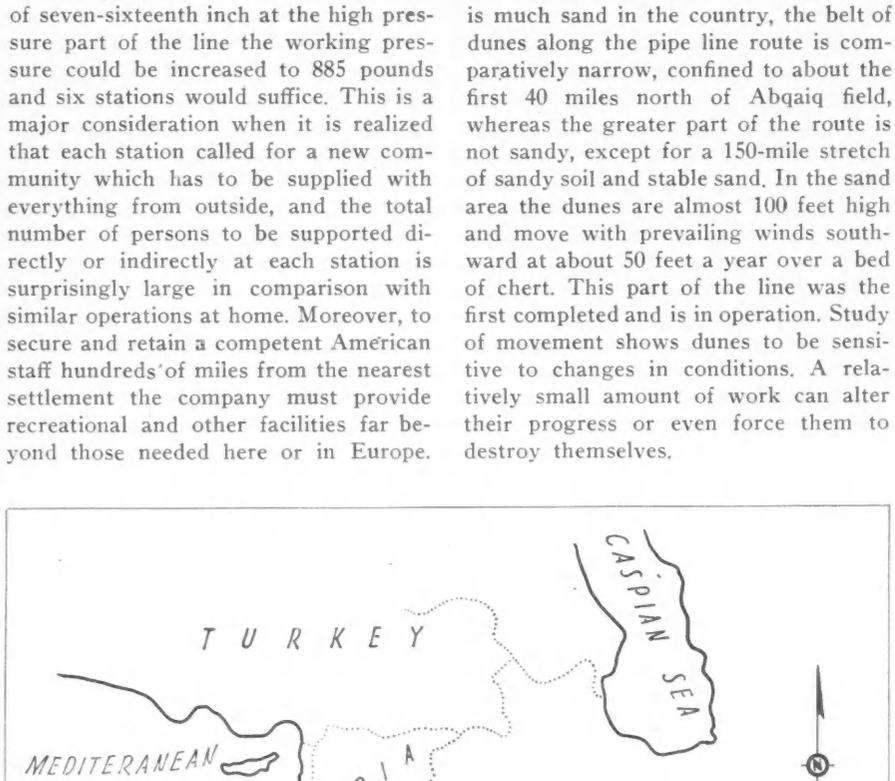
Making half the pipe 30 and half 31 inches in diameter permits it to be telescoped for shipment in cargo vessels which otherwise could not have been loaded to more than one-third of deadweight capacity with thin-wall pipe. Consideration of nesting three-deep was discarded because of added complications. One-inch differential has proved to be sufficient for nesting and de-nesting although an additional one-half inch would have avoided some scoring.

The design basis was taken as 65 per-

cent of the nominal yield point based on nominal thickness, stresses being computed by the conventional outside-diameter or Barlow formula. This gives an allowable working pressure of 570 pounds per square inch for 30-inch pipe with a nominal one-fourth-inch wall thickness. On a basis of 315,000 barrels per operating day and one-fourth inch thickness it was found that at least eight pump stations would be required. By increasing wall thickness to maximum of seven-sixteenth inch at the high pressure part of the line the working pressure could be increased to 885 pounds and six stations would suffice. This is a major consideration when it is realized that each station called for a new community which has to be supplied with everything from outside, and the total number of persons to be supported directly or indirectly at each station is surprisingly large in comparison with similar operations at home. Moreover, to secure and retain a competent American staff hundreds of miles from the nearest settlement the company must provide recreational and other facilities far beyond those needed here or in Europe.

A few months ago it became apparent the line might have to carry more oil than the original estimate. The heavy and light pipe was re-allocated to permit later installation of intermediate stations for a possible ultimate of 12. This will result in some unbalance while operating with the original six stations, but with intermediate stations added the line will deliver 500,000 barrels daily.

Many persons picture Arabia as a wilderness of sand, and although there is much sand in the country, the belt of dunes along the pipe line route is comparatively narrow, confined to about the first 40 miles north of Abqaiq field, whereas the greater part of the route is not sandy, except for a 150-mile stretch of sandy soil and stable sand. In the sand area the dunes are almost 100 feet high and move with prevailing winds southward at about 50 feet a year over a bed of chert. This part of the line was the first completed and is in operation. Study of movement shows dunes to be sensitive to changes in conditions. A relatively small amount of work can alter their progress or even force them to destroy themselves.



Proposed route of the line.

To the west the terrain is flat rock and gravel plains, virtually treeless but supporting a sparse growth of grass which furnishes grazing for the sheep, goats and camels of the Bedouins for part of the year. The plains are underlain by a gypsum which appears hard but is handled easily by a ditching machine. Worst feature is that truck tires quickly get through the gravel and reduce the underlying material to a powder which makes hauling difficult. Parts of the plains are extremely rough, covered with fractured stone piled in irregular heaps which make road construction almost impossible. Most of this has been avoided by slight adjustments in routing. The country is traversed by dry washes known as wadis which although troublesome, have offered no serious construction difficulties.

Lava Beds

When the line approaches Trans-Jordan near Milepost 860 it enters the lava beds. Construction is moderately difficult. A road can be made by sweeping away the surface boulders and putting in enough binding material to stabilize the sand, but sub-surface boulders make ditching operations difficult. Beyond the lava beds the country becomes more built up with occasional settlements of permanent structures.

Interesting also are the salt bogs or "sabkhas" of Eastern Arabia, which are permanently wet and have an almost absolutely flat surface since they are natural pools of salty water blown full of sand, forming a surface just damp and smooth enough to keep more sand from adhering. The crust may vary from damp to very dry depending upon the location and the season, but the bogs are always wet beneath the surface. The line crosses several of them, supported on steel piles with I-beam caps and held in pressed-steel ring girders. Roads can be built across the sabkhas by proper grading and bringing in some outside material.

From a standpoint of pipe line construction the terrain can be classified as follows:

(1) Moving dunes; (2) sabkhas; (3) stable sand with small bushes, known locally as dikaka; (4) gravel plains; (5) rocky plains or plains with rock at varying distances below the relatively flat surface; (6) lava beds; (7) more or less cultivated land near the Mediterranean, much of it being rocky hills.

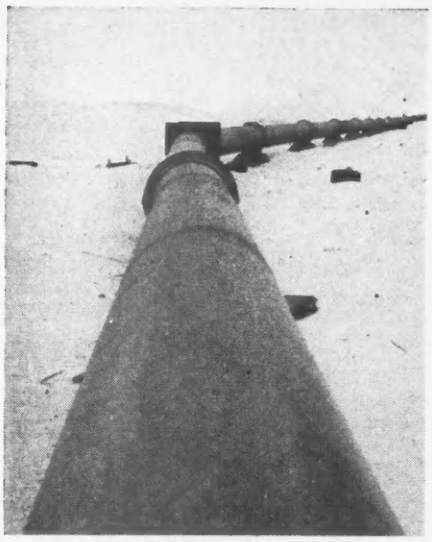
In profile the northern plains of Arabia slope gently and fairly uniformly upward from east to west, reaching a summit in Trans-Jordan only a little more than 100 miles from the Mediterranean coast. Maximum elevation on the line is nearly 2900 feet at Milepost 785, but the controlling elevation on the line

originally laid out was only about 2200 feet and was at about Milepost 1025. At approximately Milepost 1032 the line will plunge precipitously into a valley 13 miles north of Lake Hula, descending to an elevation of 740 feet at Milepost 1042, then cross a spur of hills, reaching an elevation of 1600 feet five miles from the valley floor. It will again descend to 700 feet at Milepost 1052 at the Nahr el Litani, a river which drains the Beqaa Valley in Lebanon but turns westward and empties into the Mediterranean 8½ miles south of Sidon instead of entering the Jordan. The line again reaches 1700 feet altitude crossing the southern-most spur of the Lebanese mountains, descending more than 1000 feet in the last four miles to the terminal. Here it was necessary to have the pipe capable of withstanding the maximum head of some 2500 feet.

Where the line crosses moving dunes it has been buried, and a good deal of work was done in moving sand to lay the pipe in as stable a situation as possible, but it will have to be watched and perhaps readjusted as the sand moves. Across sabkhas the pipe is supported on piles as previously mentioned. Across stable dikaka the line is buried. It will also be buried across the gravel plains where reasonable excavation by ditching machines is possible. Across the rocky plains three methods of construction will be used, depending on the depth of the rock below the surface. Where deep enough the line is to be buried. Where rock is about two feet below the surface the line will be laid on a well-padded support after exacavating as far as the rock and then mounded over with soil to hold it in place. Additional anchorage will have to be provided at horizontal changes in direction or vertical overbends. Where the rock is near or on the surface, the line will be supported a few inches above ground on small concrete pads with pressed steel girders on 66-foot centers.

On above-ground construction, several methods were considered to allow for expansion, since the pipe line must operate with a temperature range of more than 100 degrees. Expansion joints were out of the question, and expansion loops in such large diameter pipe would increase friction and increase the length considerably. Also, each ring girder support would require a sliding plate on its foundation and have to be guided laterally. It could also have been laid in a zig-zag fashion such as has been used on small lines in Iran, but in such a large diameter with more deadweight per foot, friction on the supports would be magnified and require expensive anti-friction supports.

A careful study resulted in decision simply to hold the line rigidly in place, since it would then be under no more



Above-ground construction in sandy area between Abqaiq and Qatif.

net stress than it could withstand. It was calculated that rigid placement would result in an axial stress of about 14,000 pounds per square inch over the likely temperature range, not thought excessive in view of the fact that circumferential tensile stresses were more than double that amount. The temperature of installation was assumed to average between 80 and 90 degrees.

In addition to the axial stress due to temperature, there is also that of internal fluid pressure which, in tension amounts to 30 percent of the circumferential stress instead of the 50 percent that it would be with a free-floating line closed at the ends. This tends to offset the compressive stresses set up by temperature rises in the more highly stressed portion of the line. The possibility of failure in shear was discarded since there appeared to be no mechanism by which a complete failure in shear could take place in a structure of this kind.

Vibration From Wind

Another problem to be considered was that of vibration caused by wind. During a "shamal" or north wind which sometimes blows at 30 miles per hour for days, the natural vibration of a 30-inch pipe line filled with oil and laid on 20-meter supports is about 2.6 cycles per second. The tendency to rotate in the wind supposedly disappears from 30-inch isolated cylinders at a wind velocity of about 20 miles per hour at which time its exciting frequency is estimated to be between two and three cycles per second. It was realized that this could not be applied to a pipe line close to the ground and the decision was to lay the first part of the line, see what happened, and then do something about it if it proved necessary. Up to now the line has shown some vibration but the deflections have been no more than about one-half inch by actual measurement. There has been no evidence of resonance at any wind velocity, but there is some evidence that the line goes into free vibrations of small amplitude at its natural frequency at certain times, perhaps after receiving a shock excitation from winds.

An unexpected, and rather spectacular failure of pipe occurred during hydrostatic field testing of the line on a long, straight section laid on two-pile bents with I-beam caps under ring girders. One of the longitudinal seams opened for about three feet while pressure stood at 730 pounds and stress was 84 percent of nominal yield point. About a mile of the line moved axially away from the break on both sides, movement being as much as 12 inches in places, crippling the pile caps and ring girders of many supports. Several theories have been advanced to explain the movement. The line had been under unusual stress as a result of having one long section installed under temperature conditions widely varying from adjacent sections. The first theory, regarded as probable, was that friction on supports prevented equalization of locked-up stresses until the shock wave caused by the break provided enough force to break loose the static fractional resistance of the supports and largely to equalize the axial stress already present, although this theory does not explain why the pipe moved away from the break on both sides with no apparent movement at the point of failure. At least part can be due to release of longitudional tension with release of pressure. Calculated tension at 730 pounds pressure is 13,000 pounds per square inch. Release of this tension is equivalent to a compressive wave in the pipe which could result in a cumulative movement of 14 inches one-half mile from the break if there were no friction. Two other sudden failures produced no comparable result, and this is the principal reason for concluding that most of the axial movement was due to unequally distributed locked-up stresses. Following these experiences precautions were taken to free adjacent sections of the line before welding them together. Full-strength anchors will now be installed at 2000-meter intervals to localize results of any future failures.

About 350 miles of the line will be above ground and the remainder will be either partially or completely buried. The buried portion will be wrapped with a primer, heavy coat of asphalt, a wrap of glass fabric, second asphalt coat and finally an exterior wrap of asbestos fabric. The bottom of the ditch will have fabric padding to minimize damage before backfilling. Cathodic protection will be applied where warranted.

In hydraulic calculations during the

design of the pipe line, a uniform viscosity of 12 centistokes was used, but as more definite evidence accumulated they were revised and refined until most recent calculations are based on average viscosity of 4.8 at the beginning of the line and 7.9 at the Mediterranean terminal. These are based on temperatures of 100° F. and 70° F. respectively. These will vary somewhat between winter and summer, and there will be diurnal variations in the part of the line laid above ground. The Lees equation was used on all early calculations. Various curve sheets were drawn from time to time to facilitate the numerous calculations made on the basis of innumerable variations, but much of it was done on the slide rule by means of the following equation:

$$P' = \frac{70.7\ Q^{1.8}\ S_{60}^{1.8}\ \nu^{.2}}{S_t^{.8}\ D^{4.8}}$$

$$h' = \frac{163.2\ Q^{1.8} \left(\frac{S_{60}}{S_t}\right)^{1.8} \nu^{.2}}{D^{4.8}}$$

where

P' = rate of pressure loss in pipe line, pounds per square inch per statute mile

h' = hydraulic gradient, feet per mile

Q = flow rate in pipe line, in units of 100,000 U. S. bbls. per day, measured at 60° F.

S_{60} = specific gravity of oil at 60° F.

S_t = specific gravity at flowing temperature t

ν = kinematic viscosity of oil in centistokes

D = inside diameter of pipe in units of ten inches. (i.e., 30-inch pipe would have a diameter of three)

(The shift of the units of Q and D has been made to facilitate the use of a log-log slide rule.)

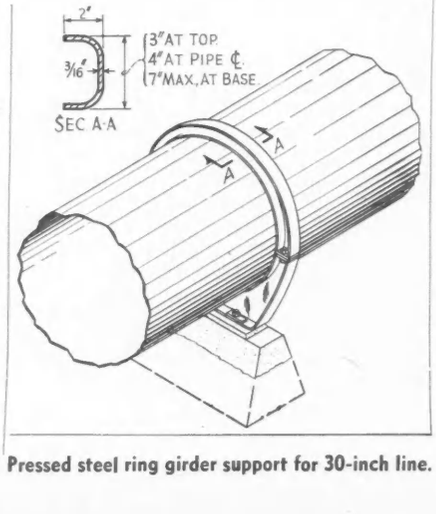
With ports in the Ras Tanura and Dammam areas busy with shipping for the producing and refining branches, the base camp at Ras el Misha'ab was selected for construction of facilities for receiving materials for the pipe line. Located in the extreme northeast corner of Saudi Arabia, it would be more convenient to the majority of the work, and do away with the necessity of heavy roadbuilding through the sand dune and sabkha country. Deep water does not approach closer than three miles offshore, but unloading of pipe which constitutes the greater part of the tonnage has been done efficiently through construction of a "sky hook" such as is used in the U. S. Northwest for hauling timber by aerial cableway. Self-propelled cabs below which are hooks for carrying the pipe, haul the material the three miles from offshore ships.

The pumping stations on the TAPline are interesting because of their size rather than for unusual features or departures from ordinary practice. A careful study was made at the time of their design to determine whether they should be driven by steam or by internal combustion engines. In many operating matters steam would have advantages, and sufficient water could be obtained along the right-of-way, but over-all economy finally dictated the use of diesel power at all pump stations with the exception of No. 1 at Abqaiq where there is an unlimited surplus of sour gas for fuel. Here two 6000 horsepower steam turbines are directly coupled to two-stage centrifugal pumps, each capable of delivering 340,000 barrels daily against a maximum pressure of 840 pounds. Exhaust steam will be used for heating in a crude oil stabilizer but can be rerouted to dry air-blown condensers if operation of the stabilizer does not parallel pumping requirements.

Adequate Pressure

Adequate pressure on the suction is provided by two vertical pumps in the tank farm, each capable of delivering full line capacity at about 75 pounds per square inch. All usual accessories to a modern station are to be used. Among these are automatic flow and pressure controls, a recording flow meter for the main stream, and remote reading tank gauges. Precision gauging of oil for royalty purposes in this area is accomplished by balancing the oil column against a mercury manometer which, when properly done, has been found more accurate than the conventional method of tape gauging used in this country.

Although of conventional design, the pumps at Station 1 are perhaps the largest units of their type ever built: two-stage, 340,000 barrels per day, 840-pound, 3600 revolutions per minute and 87 percent efficiency. On account of the large shaft and high peripheral velocities and comparatively high pressures, packing difficulties were feared and it was finally decided to eliminate packing and install labyrinth bushings successively bled to lower pressures and finally to a sump whence the leakage is returned to the line.



Pressed steel ring girder support for 30-inch line.

Stations 2 to 6 inclusive will be of conventional type, operating with single-stage centrifugal pumps in series. The pumps are driven by 1700-horsepower diesel engines through speed-up gears, and will operate at a nominal 2200 revolutions per minute and engines at 343 revolutions per minute. Engines are eight-cylinder, four-cycle type with 16-inch bore by 20-inch stroke and are supercharged by the Elliott Buchi system. Operation will be with five pumps in series, four to meet normal line requirements and one spare. Individual units are bypassed with lines containing check valves and have motor-operated suction and discharge valves. Any unit can be started without disturbing the operation of others.

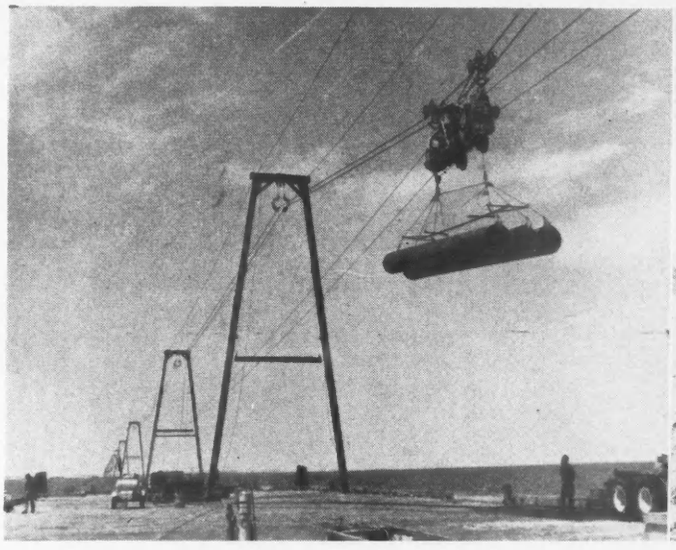
Other station equipment includes three electric generators, one a spare, for driving auxiliaries, including the fans of the extended-surface dry air-blown radiators for cooling jacket water and lubricating oil. They will also supply power for air-cooling living quarters and for refrigeration. There are pumps for water wells and booster pumps for putting pressure on the main suction when oil must be drawn from the station tank. Generators will be driven by six-cylinder engines with the same cylinder dimensions and other general characteristics as the pump engines.

Stations are piped so they will operate either straight-through with closed suction or by floating a 96,000-barrel tank on the line coming into the station. In the latter case the electrically driven booster pumps will raise pressure on the suction of the main pumps to prevent cavitation.

Actually the extent to which the stations will be operated with closed suction is still uncertain. Unless precautions are taken to limit surge pressures to one section, pressures generated by the various stations can be cumulative and result in overpressuring the line. Also, where much of the line is above ground and exposed to sunlight each station receives more oil during the day than is pumped, and pumps more at night than is received. Cumulative difference in 1000 miles of line would be substantial since capacity of the line during the day would be limited to the last section and during the night by the first section.

Precautionary measures will include relief valves of special design on both incoming and outgoing main lines, and over-pressure trips will be installed to shut down one or more of the engines in case of excess pressure on the discharge.

Conventional scraper traps are being installed. The Arabian oil is somewhat



Three-mile cableway at Ras el Misha'ab with "Skyhook" carriage.

Above-ground construction on pile bents across sabkhas.

waxy, but lines between the fields and the Gulf have not had trouble largely because the oil has never had a chance to cool off in the short distances involved, but wax has accumulated in the tanks. In the higher elevations on Western Arabia and Transjordan, the oil temperature may fall as low as 55 degrees. It is understood that Iraq oil received at Haifa terminal falls as low as 57 degrees in winter although the annual average is a little above 70 degrees. Scrapers will be of value to remove air during filling of the line, to separate water used for testing from the oil, and to remove the rubbish which gets into lines during construction.

Pump and engine houses are 230 feet long and 170 feet wide, pump room being separated from the engine room by a gas-tight firewall. Present plans are for construction of six dwelling houses at each station in addition to the superintendent's house, and a four-room bunkhouse for single employes. There will be a children's playground, tennis court, baseball diamond and a swimming pool as well as a community center and an infirmary.

In addition to housing for Americans there will be quarters for about 24 Arab families and 200 Arab bachelors.

Communications along the pipe line received careful consideration from the start with both wire lines and various forms of radio being considered. Wire line has drawbacks, including expense and exposure to damage including intentional or unintentional sabotage by curious or malicious bands of nomads, but most important was that it would not be available during construction when communications were as urgently needed as for operation.

The best type of radio for guaranteed performance under all weather conditions would be high frequency of the line-of-sight type, but this would require towers and power at inaccessible spots, and unattended it would also be subject to damage. At the same time it could not be obtained in time for construction of the line and possibly not in time for line operation when opened.

Short Wave Used

It was decided that ordinary short-wave was needed in the construction program with possibility that experience might indicate it could be expanded into a permanent system. This was based on the remarkable performance of low power transmitters operating on a frequency of about four megacycles, used in automobiles by Arabian American Oil Company geologists.

Temporary equipment consists principally of 1000-watt transmitters at Beirut and Ras el Misha'ab with 300-watt transmitters at the main intermediate construction camps, 50-watt outfits at temporary tent camps and 15-watt transmitters in certain of the motor equipment. The through communication between Misha'ab and Beirut, an airline distance of about 850 miles, has been almost faultless. Various frequencies can be used between three and 18 megacycles, and two are normally set up, but the changeover is manual. Communication with the 50- and 300-watt transmitters is also excellent, and at times even the 15-watt automobile sets have been able to communicate three-quarters of the way across Arabia. Of course this is unusual and not to be depended on, but the automobile transmitters have ordinarily been able to get in communication with the nearest construction camp without difficulty.

The permanent installation, it is contemplated, will be two more or less separate systems, one a through system from Sidon to Dhahran, and the other a dispatching system for the pipe line taking in all intermediate stations. The through system will have 1000-watt transmitters feeding to rhombic antennas designed for single-hop transmission. Three rhombic antennas will be used for reception with a diversity receiving arrangement automatically selecting strongest signals to eliminate fading. The dispatching system will use three frequencies simultaneously to provide dependable communication to any or all stations at distance from 125 to 1000 miles. Frequencies will be about 5, 10 and 16 megacycles.

At the Mediterranean terminus a few miles south of Sidon, where the Zahrani River empties into the sea, there will be 16 tanks of 180,000-barrel capacity at elevations 285 to 378 feet above the water. The tanks will be 5200 to 7200 feet from shore. Four 30-inch submarine loading lines will extend 2700 feet from shore to a point where water is 50 to 55 feet deep, and there will be ballast lines to a separator on shore. Individual tanks will be connected by 30-inch lines to a manifold from which the submarine lines will lead. Other facilities will include ship-to-shore communication between ship, manifold, and tanks, a small pier for launches necessary for handling mooring lines, minor supplies and transferring personnel.

Although changes in plan of radio communication setup may be made before construction, currently the permanent transmitting station is to be located at Sidon rather than Beirut where the present station is situated, but the company headquarters will probably remain in Beirut, about 30 miles to the north, which is also the metropolitan and commercial center of Lebanon.

Emperor Attends Spudding of

Ethiopia's First Well

SINCLAIR'S drilling operations in Ethiopa are transforming the life and economy of many native tribes living in the vicinity of the company's first test well in the Gumboro Hills. The first well was spudded in the middle of May at ceremonies attended by Emperor Haile Selassie. The enterprise quickly won the friendly support of thousands of Somali tribesmen, a decided change in attitude over a year ago when natives attacked equipment and did damage to waiting machinery.

Now the Somali tribesmen are pro-American, and the Sinclair 15-acre camp is peaceful. The company has won the favor of the natives by giving water to any of the tribesmen who ask for it. Sinclair has a 900-foot water well operating and its personnel has even carried water to Somali villages, the inhabitants of which were unable to come to the well for it.

Also, the company's doctor has treated many Ethiopians and saved the lives of a number with the facilities of the modern camp hospital.

After one of the quick, infrequent rains of the area, the company's power wagons transport Somalis to the newly-watered grazing spots before the moisture dries up.

Above: Sinclair's well, Gumboro No. 1.

Left: The Emperor puts into motion the machinery for drilling the first exploratory well in Ethiopia.

Canada's Oil Laws Revised

By ROY E. LEIGH
Staff Writer

THE Alberta Legislature met in a special called "oil" session at Edmonton July 4-7 and enacted into law six bills prepared by provincial authorities having interest in and regulatory control over the oil and gas industries on an intra-provincial basis. These laws have the effect of re-writing provincial laws affecting the expanding oil and gas industries within Canada's leading oil province.

The revised laws grant new powers to the Petroleum and Natural Gas Conservation Board and to the Board of Public Utility Commissioners for the rigid control of all phases of the production, transportation and marketing of oil as well as gas; and governmental machinery is set up which, within the discretion of appointive boards, can be employed to allow the export of gas beyond provincial boundaries, hitherto prohibited by law.

The Oil and Gas Resources Conservation Act has been amended to grant to the Petroleum and Natural Gas Conservation Board, acting by and with the consent of the Lieutenant Governor in Council, the power to control production to prevent physical waste, and to prorate the production of oil and gas on a province-wide basis with respect to available market demand, from foreign as well as domestic sources. The new and expanded powers of the Board include the authority to declare any purchaser of oil or gas to be a common purchaser, and any carrier of these commodities may be classified as a common carrier. By calling for approval by Lieutenant Governor in Council it appears final say will rest with the leaders of the party in power.

The legislation is perhaps the most far-reaching ever enacted by any democratic law-making body, in that it recognizes a prior right of the local citizenry in the enjoyment of natural resources before any surplus may be exported, even to fellow-Canadians living in other provinces; it grants correlative rights to owners of sub-soil rights in a common pool; and goes so far as to provide that available market demand may be prorated among pools and fields over the entire province.

These amendments were sponsored by the Social Credit Party, which rose to power during the depression 20 years ago. Sobered by authority and made cautious by responsibility, it is now less socialistic in practice than in name and doctrine.

Coal Industry Objects

The party is dominant in Alberta's provincial politics, and certain features of the new laws were opposed by minority members representing the Liberal and CCF parties, whether from force of political habit or otherwise. Objections were raised on behalf of Alberta's substantial coal industry, and by representatives of local consumers of industrial and domestic fuels, on whose behalf priority rights were asserted. It also was contended that the export sale of the province's gas assets might lessen or retard future industrial developments on the part of large users of gas, who, if Alberta's reserves should remain impounded behind provincial borders, might then be enticed or forced to move factories into the province in order to find cheap fuels.

Prospectuses have been prepared on behalf of three or more large-scale projects for the construction of large gas lines from the new fields of Alberta to other Canadian provinces and to the northern and northwestern U. S. In all probability applications for permits to allow such export of gas will be made in due course, but it is not considered likely that any such permit will be granted in the immediate future; first, because the political "dust" must be allowed to settle; second, because a staff of technical experts must be organized for processing such applications; and third, because time must be allowed for public hearings, civic discussion, etc.

Meanwhile, exploratory and drilling work may be stimulated for the purpose of outlining gas reserves in volumes sufficient to justify large investments in pipe lines and to support applications alleging the existence of exportable surpluses.

In some respects—and in some quarters—certain features of these new acts are considered as forward-looking; for example:

"The intent, purpose and object of this Act is:

"(A) to effect the conservation of the oil and gas resources of the Province;

"(B) to prevent the waste thereof; and

"(C) to give each owner the opportunity of obtaining his just and equitable share of the production of any pool."

Powers of the Board

"**16.**—(1) The Board is hereby authorized and empowered, with the approval of the Lieutenant Governor in Council, to make such just and reasonable orders and regulations as the Board deems requisite to effect the intent, purpose and object of this Act.

"(2) Without limiting the generality of the foregoing, the Board, with the approval of the Lieutenant Governor in Council, is authorized and empowered—

"(A) to designate and delineate areas within the Province as fields and pools;

"(B) to designate the area which shall be allocated to a well in connection with fixing allowable production;

"(C) to control and regulate the production of petroleum by restriction, proration, or prohibition;

"(D) to require the repressuring, recycling or pressure maintenance of any pool or portion thereof, and for such purpose to require the introduction or injection into any pool or portion thereof of gas, air, water or other substance, and incidental thereto to provide for the compulsory purchase of any well or wells;

"(E) to require the storage in an underground formation, in accordance with such terms and conditions as the Board may prescribe, of any gas gathered which is in excess of the reasonable market demand and incidental thereto to provide for the compulsory purchase of any well or wells;

"(F) to limit the amount of petroleum which may be produced in the province—

"(i) by fixing a provincial allowable for oil not exceeding the reasonable market demand as determined by the Board; and

"(ii) by allocating the provincial allowable for oil in a reasonable manner among the pools in the province by fixing the amount of oil which may be produced from each pool without waste to meet the provincial allowable so determined; and

"(iii) by prorating the production of oil allocated to each pool among the producers from the pool, for the purpose of giving each producer the opportunity of producing or receiving his just and equitable share of the oil in the pool; and

"(iv) by limiting the total amount of gas which may be produced from any pool having regard to both the reasonable market demand for gas therefrom as determined by the Board and the efficient use of gas for the production of oil; and

"(v) by prorating the production of gas allocated to each pool among the producers from the pool, for the purpose of giving each producer the opportunity of producing or receiving his just and equitable share of the gas in the pool."

Alberta's Soaring Production

Within the last 30 months about 1 billion barrels of new oil reserves have been found as a result of discoveries at Leduc, Woodbend, Redwater and Stettler, the productive limits of none of which have as yet been defined; and that excellent showings of oil and gas have been had in several other areas believed to hold promise of production of oil and gas in commercial quantities. Alberta crude production now greatly exceeds refining capacity, and available market demand is sharply limited by railroad freight rates in the mountainous and sparsely-settled prairie farming regions, so much so that voluntary proration had already been adopted as a self-regulatory action among producers in the new oil fields.

A salient feature of the situation is that the Province of Alberta, as successor to the Crown of England, owns all sub-soil rights, including oil and gas, under approximately 90 percent of the lands. Thus, the provincial government has an intimate and immediate interest in its expanding oil industry, above and beyond those which would accrue to a state of the U. S., as much of its revenue is measured directly or indirectly by prices posted for crude oils. The government is in the oil business vicariously, as a recipient of oil and gas rentals and royalties, and in the oil business directly, as a seller of oil and gas leases at auction, where bidding values are calculated with respect to the value of crude oils, to such extent that two sections of land have been sold for nearly $6½ million. Posted prices for light oils from the new fields now range from $2.68-$2.78 per barrel at Redwater to $2.95-$3.05 per barrel at Leduc and Woodbend, with higher prices at Turner Valley, an older field with established outlets in the refining and consuming center of Calgary.

That the provincial government would be deeply concerned if a break should occur in the local price structure goes without saying. It might even be asserted that the new legislation may have been drafted for the purpose, among others, of shoring up this price structure, on which government royalties are computed, and on which land and lease values rest.

There are oil gathering systems and short pipe lines, as well as gas lines, running from Turner Valley to Calgary and from Leduc-Woodbend to Edmonton, but, so far, only one trunk pipe line has been proposed. Other proposals for the construction of pipe lines to carry Alberta gas to more populous regions, such as Winnipeg, Manitoba, Vancouver, British Columbia and Spokane, Seattle, Portland and other cities in the Puget Sound country, are said to await the outcome of legislative change, and of public and private financing on a large scale.

The people of Alberta outside the oil and gas industries find themselves in a quandary as to what to do with their new-found gas reserves. Some would allow the export of natural gas beyond provincial boundaries and others would forbid it, as heretofore done by law.

The political atmosphere may be sampled in the following report of a lively discussion before the Board of Aldermen, of the City of Calgary, whose civic leaders refer to it as "The Oil Capital of Canada":

L. H. Fenerty, K. C., special counsellor on the Natural Gas Advisory Committee, appointed by the City Council, expressed fears that prospects for the industrialization of that city, where gas rates are higher than at Edmonton, might be harmed by the exportation of gas; and said, "Objections should be raised strongly when any particular company makes applications under these rules to export gas!"

S. J. Davies, consulting engineer for the same committee, stated that American firms planning to import gas from Alberta could afford to pay much higher prices than Calgary pays, despite a recent increase in domestic rates, and could therefore offer protection as to price and reserves which the city could not. He suggested that Canadian Western Natural Gas Company, Ltd., which distributes gas to the citizens of Calgary, should be given first call on the gas reserves at Jumping Pound and Pincher Creek.

Socialization Is Proposed

Alderman Manley Edwards suggested that socialization might afford a solution to their problems, and proposed that a resolution be sent to the Alberta government asking that it undertake to produce, gather, and distribute natural gas in the province on an equitable basis; or, failing that, to form a province-wide pool of gas for fair distribution; or else help in the formation of partial pooling services for certain districts. That his motion was defeated may be accepted as evidence that public opinion in Alberta favors private enterprise for the development and utilization of petroleum and natural gas.

Only five cities, Calgary, Edmonton, Lethbridge, Medicine Hat and Red Deer, embracing about one-third of the total population of Alberta, are served with natural gas for domestic uses.

In the background of recent discussion were those who would guard the interests of the coal industry of Alberta, now outweighing the infant gas industry in all particulars, including employes engaged, revenue accruing to the provincial government, dollar-value of output, etc. Coal miners might suffer if natural gas should be made available on a competitive basis to customers within a radius of 1000 miles, as freight rates might prohibit them from seeking other outlets.

Thus, it appears that the growing oil and gas industries of Western Canada must run a political gamut, both at home and abroad. A goodly portion of

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Alberta's logical market for exportable surpluses of oil and gas, on geographical basis, would be the U. S., and if Canada should ultimately become self-sustaining as to petroleum, it still would be more economical to export oil from Western Canada into accessible regions of the U. S. in exchange for U. S. oils to be imported into Eastern Canada. The populous center of the Dominion will always be more accessible from the Gulf Coast than from the prairie provinces, as measured by freight costs. Such an arrangement, however, is subject to the political hazards attendant upon any proposal to increase oil imports into the U. S.

More immediate hazards, however, may be found in a closer study of the new legislation recently enacted at Edmonton.

Up to now, the Social Credit Party has been inclined to foster its growing oil industry, and few complaints have been heard from oil operators regarding conservation practices and regulations as enforced. But it remains to be seen whether the legislative body has found the wisdom, in re-writing all its petroleum laws at one stroke, to provide a new legal system within the confines of which the youthful industry may grow and prosper.

It has been said that proponents of the several draft bills adopted may have been fearful of another situation such as developed in East Texas in the 1930's, and that it may have been their intention to provide their Petroleum and Natural Gas Conservation Board with powerful controls to prevent a run-away boom and a market-breaking oversupply of oil.

Another hazard which might have grown out of this situation in the absence of rigid controls is the construction of "tea-pot" refineries of the type which caused so many headaches among tax-gatherers in East Texas.

A committee representing the membership of the Western Canada Petroleum Association was heard by the Provincial Cabinet, prior to the meeting of the Legislature, in support of certain features of the proposed legislation and in opposition to others. On representation by the Association, provincial authorities sponsoring the new legislation consented to the removal of a clause which would have forbidden appeals to the courts on decisions of the Petroleum and Natural Gas Conservation Board; and in final form the new laws allow the right of appeal on questions of law and jurisdiction. Other modifications were proposed by the Association, and adopted by the Cabinet, so that the new legislation omits some of its original features which might have been objectionable to the industry.

Venezuelan Nationals Form Oil Operating Company

Compañía Nacional de Industrias S.A,. a new domestic Venezuelan organization, has been formed to promote the organization of companies to engage in exploration, drilling, production, refining and transportation of Venezuelan crude through the use of Venezuelan capital and technical skills. The new concern will operate through a subsidiary, Compañía Nacional de Petróleos S.A., which will seek concessions from the Venezuelan government on part of the 44,478,000 acres of oil-bearing land now under concession to private companies.

To Remain National

The new setup has been formed by Venezuelan business interests, and according to Dr. Miguel Marquez Rivero, president of Compañía Nacional de Petróleos, the Venezuelan stockholders will not allow control to pass to "foreign trusts," and all profits of the enterprise will remain in Venezuela "to strengthen and develop basic national industries such as agriculture and stockraising."

A large part of the original Bs 5 million bolivars ($1½ million) capitalization is reported already subscribed and consideration is being given increasing capitalization to Bs 10 million through issuance of extra shares of Bs 1 each, which will be traded on the Caracas stock exchange.

The parent industrial company will be capitalized at Bs 100,000, of which 20 percent already has been subscribed. It will promote the formation of companies to explore, drill, refine, and transport Venezuelan crude. The purpose of Venezuelan companies now entering into the petroleum field is reported to be "to stimulate industry in general and result in more complete and efficient exploration of sub-soil deposits." An administration contract has been reported signed with "a group of well known petroleum consultants who will be in charge of operations until the administration of the company can be assumed by properly trained Venezuelans."

Dr. Rivero said that only 8 million hectares of the total of 22 million in Venezuela which possibly contain petroleum, have as yet been assigned as concession to presently operating companies, and added that "the time has come when Venezuelans should take an active part in the exploitation of the mineral resources of their own country.

A Venezuelan lawyer, Eduardo Lopez Ceballos, is reported to have filed application to incorporate in Venezuela the U. S. firm of Catawba Oil Explorations Company, which "will devote its time to exploitation and marketing of oil."

Tunisia Is Divided Into Three Prospecting Zones

There have recently been some important developments in the outlook for an intensification of the search for oil in Tunisia and in Algeria, North Africa. In line with their general petroleum policy which now seeks to obtain the maximum of exploration in its colonies, the French government has divided the main part of Tunisia into three zones, giving prospecting rights to two major British and American companies, and to its own operating entity. The zones are to contain areas of 11,630 square miles, 7580 square miles and 5850 square miles respectively, and will be operated in that order by Société des Recherches et Exploitations de Pétrole en Tunisie (SEREPT), Société Nord-Africaine des Pétroles Gulf and the Compagnie des Pétroles de Tunisie Shell. The first named is the official French company owned jointly by the French and Tunisian governments, which also owns a 35 percent interest in the other two companies, the remaining 65 percent being held by Gulf Oil Corporation and the Shell Group respectively.

It is anticipated that the American and British groups will spend about $14 million each on prospecting and exploration work over the next four years. The Tunisian government will receive a royalty of ten percent of the value of the output from any fields discovered. The outside groups have also agreed to take care of local consumption needs once production is obtained, and to supply a local refinery which may be built by the Tunisian government, and in addition will use production from discovered fields to supply or help supply the needs of France herself if requested.

In Algeria it has been reported that a wildcat well drilled at Aumale, south of Algiers, had been completed at a depth of 2400 feet for an initial production of 35 barrels a day, and that promising oil showings have been found at Oued Guetarini, in the same area. The latter well is being deepened.

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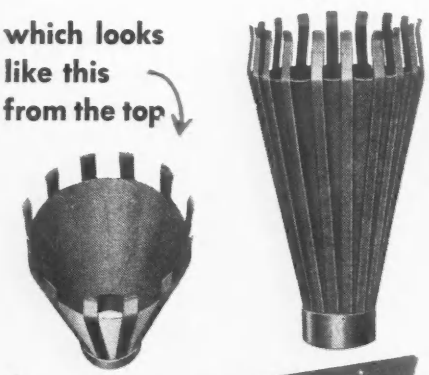
which is made for use on all popular sizes of casing from 4½ inch to 10¾ inch A.P.I. or O.D. This Basket is constructed of a number of individual "petals" made of flexible sheet metal. These petals are mounted on reinforcing spring steel ribs, which are in turn mounted on a "ring." The petals overlap each other (even in their expanded position) by a sufficient margin to prevent movement of fluid past the Basket. Next we take the assembled Basket

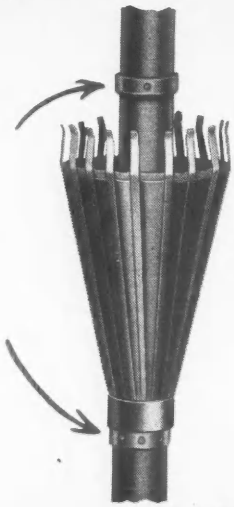
which looks like this from the top



and we mount it on a nipple like this

or if the casing string is to be rotated or spudded

the basket is mounted "slidably" with stop rings to limit its vertical travel



Next, we can attach to the top a Baker Cement Whirler Float Collar

with Solid Bottom Baffle, Product No. 305, forming Combination Product No. 306; or, we can attach to the top of a Baker Plain Hook-Up Nipple with Metal Petal Basket and Solid Baffle (Product No. 333) a Baker Cement Whirler Float Collar (Product No. 304) making Combination Product No. 303. See Figures 1 and 2.

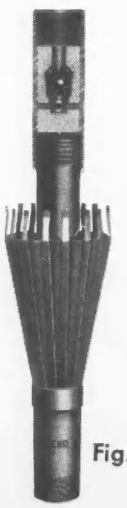


Fig. 1

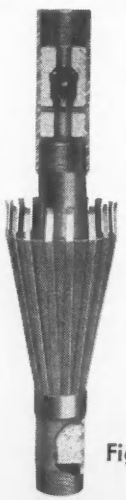


Fig. 2

Or it may be you want to protect zones both above and below the cementing point

. . . which calls for mounting a Baker INVERTED Metal Petal Basket *below* the upper zone, with another Basket (facing up) mounted *above* the lower zone. The steel straps which hold the lower (flared) end of the INVERTED Basket against the pipe while the string is being lowered, are severed when any tool or pipe is run through the nipple; see Figure 3. A typical application of an opposed Basket hook-up – used with a Baker Cement Retainer for cementing a blank section of pipe) is shown in Figure 4.

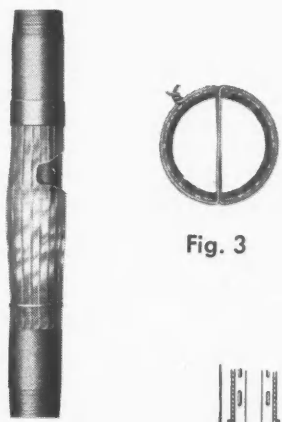


Fig. 3

Inverted Metal Petal Basket to protect upper zone

Cement Retainer

Metal Petal Basket run in normal position to protect lower zone

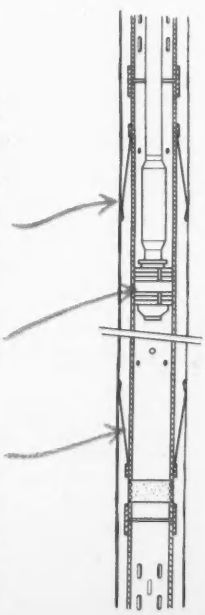
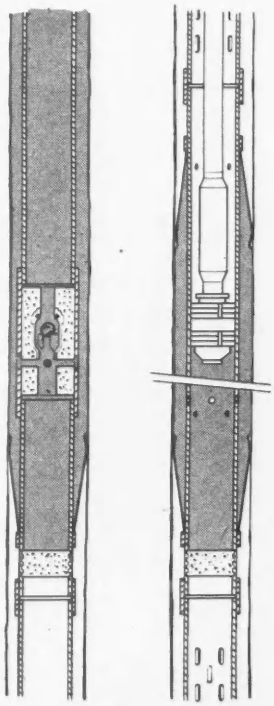


Fig. 4

Okay, now start pumping cement!

After the string has been lowered to position the Basket (or Baskets) at the predetermined point, cementing is performed in the usual manner. The Metal Petal Basket expands to pack-off against the walls of the hole, even if the bore is irregular in shape, or of increased diameter. The baffled whirler ports in the Baker Cement Whirler Float Collar impart a "whirling" motion to the cement slurry which assures the best chance for uniform cement distribution with a minimum hazard of channeling.

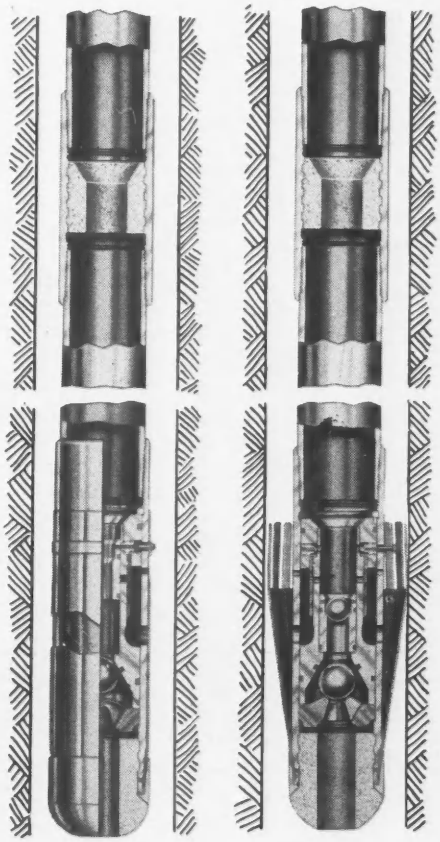


There is nothing complicated or "hard-to-do" about it

... and a better cement job usually is obtained, with any low-pressure, permeable zones protected from contamination by the cement slurry.

But, you haven't seen anything yet!

One of the newest, most efficient applications of the Baker Metal Petal Basket is its use with the Baker Triplex Cementing Shoe (Product No. 136) which serves as a conventional float shoe while running-in, washing, and conditioning the hole in advance of an initial cementing job on a string of casing. Action of the "Triplex" Shoe is pictured in Figures 5 and 6, where a Baker Model "G" Casing Centralizer holds the casing centered to provide a uniform annulus above the shoe to receive an even, effective body of cement—while the expanded Metal Petal Basket protects any lower, permeable zones.



Closed
Fig. 5

Expanded
Fig. 6

Isn't that "really something" and very interesting?

Full details of the remarkable Baker Triplex Cementing Shoe can be secured from any Baker representative or office; and your Baker (or Composite) Catalog contains complete information.

There are many combinations all ready for you

A wide range of combinations, for a great variety of hook-ups and applications—field-tested on hundreds of jobs—are available to meet your every cementing need.

So what are we waiting for?

You know that Baker makes the most complete line of cementing equipment—from shoes and collars to cement retainers and wire line bridge plugs. For many years Baker admittedly has been "Cementing Headquarters" ready with the right equipment and thorough knowledge to perform not only simple, routine casing cementing jobs, but also those difficult remedial cementing operations requiring special combinations and "tailor made" hook-ups.

Ask any Baker man! Phone or write to any Baker office!

There are Baker representatives in every active area, ready to make an "on-the-spot" analysis of your every cementing problem. Why not get in touch today with the Baker man in your field and be ready to handle your next cementing job safely, efficiently and economically?

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Houston • Los Angeles • New York

...with Baker "Metal Petal" Cementing Baskets

Italian Discovery Is Focal Point of *Political Dispute*

WHATEVER may be the ultimate value of the new Cortemaggiore field to Italy's economy, there is now no doubt that the discovery has become the focal point of a struggle between nationalistic factions and those who would welcome the investment in Italian oil possibilities by foreign capital.

The state-owned Azienda Generale Italiana Petroli, which discovered the field, points to it as an example of the progress made by a national concern and claims it would eventually supply as much as 20 percent of Italy's crude oil requirements. On the other hand, Ivan Matteo Lombardo, Minister for Industry and Commerce said in a speech to the Senate that forecasts of the field's possibilities, even if correct, could cover at the most about 2 percent of the nation's crude consumption. He emphasized that in order to do this there must be investments of several billion lire. The Minister conceded that the discovery is a noteworthy step in the direction of solving part of Italy's supply problems, but that the full solution lies in putting into effect a mining law which would allow foreign capital to be invested. Interest on the part of foreign companies has been shown by the 800 applications pending in anticipation of acceptance of recommendations by the Superior Mining Committee, but the recommendations have been rejected by the Cabinet.

The *Nuovo Corriere della Sera* of Milan, a leading Italian daily, insists the government should protect the country against a foreign monopoly as regards oil properties, but leading business circles point out that AGIP has found it impossible to finance the type of exploration and development program which would be required to prospect favorable territory adequately. These latter argue that should the state company gain a monopoly it would eventually be forced to seek outside aid from foreign oil concerns, and thus indirectly cause intervention which they profess to be trying to avoid.

Still another thought has been expressed by Italian business leaders: that perhaps behind the whole dispute might be foreign interests trying to hinder the expansion of American business. There have been unofficial reports that some American companies have planned to relinquish part of the Italian market in favor of British concerns.

As regards the gas producing area itself, Cortemaggiore is one of the largest single gas fields in the Po Valley, covering about 10,000 acres already proved, but the basis of misunderstanding so far has been its possible importance as a producer of crude oil.

Recently, the management of the government-sponsored company has announced that the organization does not want to monopolize the oil and gas research in the nation, but that it is prepared to continue its activity in competition with private concerns in line with certain press campaigns for free competition in the industry. The leading Italian daily papers have emphasized that there is plenty of work to be done by everyone in the oil and gas fields of Italy, and that on account of the limited resources of AGIP and the high cost of exploration in the Po Valley, the government organization will of necessity have to reserve a comparatively limited amount of territory for its operations.

Well Reports

In its official statement regarding the Cortemaggiore oil discovery, the Ministry of Industry and Commerce said that the two wells drilled by AGIP at Cortemaggiore have cut more than 325 feet of section in the Messinian. Well No. 2, the shallower of the two, has found three principal porous horizons, all of which contain natural gas. Well No. 1 has cut the same formations, finding them structurally higher and finding gas in the two upper zones. However the lower zone showed oil in a 30-foot section bottomed at 5218 feet, and on flow tests the well produced up to 35 barrels of oil daily at gas-oil ratios of approximately 10,000 to 1. Better tests have been halted by the tendency of the separators to freeze while the well is flowing, so that no definite conclusion has been reached as to its actual potential or the possible importance of the field. The well was drilled to a total depth of 6232 feet without reporting any further showings. According to the Ministry a considerable additional amount of drilling will be necessary before the oil producing area can be outlined, and any reserve estimates made.

Of primary importance to the Italians is the fact that the well has shown crude oil in place, apparently in the same geological formations in which it was formed. This has renewed hopes that more crude may be found in the Po Valley, both in deeper structures and in much younger formations.

The gas field itself is considered more important than most, since all of the other Po Valley gas fields produce dry gas, while the gas from Cortemaggiore contains important quantities of natural gasoline and other liquids. The Ministry also estimated that should the quantities of crude revealed during the early tests be confirmed in later operations, it was expected that the field might be brought to the point where it would produce as much as 750,000 barrels yearly.

Commenting on the importance of natural gas itself to Italian economy, the spokesmen indicated that with completion of more gas transmission and distribution pipe lines, by 1953 the production and use of natural gas would correspond in energy value to 1½ million tons of coal yearly. Present consumption of coal is about 9 million tons a year.

Some credit for clearing up the details of the Cortemaggiore discovery has been given by Italians to the resolution adopted at the International Methane Congress, through which the privately owned oil and gas companies in Italy asked the government immediately to establish, through passage of a mining law, the basis for acquisition of concession areas by private companies who have appropriate organizations and are ready to operate in the national interest.

The resolution was supported by figures showing the amount of work done in the past in the form of actual footage drilled in various areas since they began operating as far back as 1909. One company, the Petroli d'Italia, of Milan, submitted figures showing it has drilled 600 wells in 12 separate areas representing a total of more than 1,300,000 feet of hole.

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AERO, who pioneered the vast, Shoran-guided airborne magnetometer survey of the Bahamas, completes another major exploration—this one in Africa!

In July 1948, AERO began the aerial mapping-magnetometer survey for Mozambique-Gulf Oil Company's concession in Portuguese East Africa. Flying was completed in early June of this year. Completed maps of the 47,000 square-mile concession will record magnetic variations as small as 2 gamma. Gulf geologists will use these maps and our detailed aerial photography to quickly locate areas of particular interest—thus saving months of bush exploration.

AERO has made extensive mapping and magnetometer surveys over the frozen north as well as the tropic jungles—from Alaska to South America—from Newfoundland to South Africa.* AERO's surveys *move*, and cost substantially less because they are backed by close liaison between the home office and field . . . *by on-the-spot ability to get the job done.*

With thirty years' experience in aerial mapping, AERO is fully qualified to quickly and economically fulfill your aerial mapping requirements *anywhere in the world.* Our photogrammetric engineers will be glad to discuss with you how we can aid your exploration and development planning.

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Canadian Line

To Relieve Prairie Oil Surplus

THE Canadian oil boom has reached a stage where local markets are surfeited, proration has been instituted, and market outlets cannot be extended until major pipe lines have been built. To complete the picture, controlling legislation was enacted in a recent special oil session of the Alberta Legislature.

Much of this new production of light and valuable oils is found at relatively shallow depths in comparatively easy drilling in a country where many factors favor the development of low-cost production, except that the rigors of the Canadian winter force a seasonal slowdown.

It is, perhaps, fortunate from the point of view of U. S. producers—who already have lost the prairie markets of Western Canada—that Alberta is isolated from the more populous markets of the continent by barriers of distance and railroad freights. The ultimate loss of other good markets in the Middle West is to be contemplated by U. S. oil producers with what composure can be drawn from the realization that the logical and economic utilization of western Canadian oils seems to indicate the wisdom of a sort of "trade-out" arrangement, whereunder Canadian oils may be marketed in contiguous sections of the U. S. in exchange for Coastal and Mid-continent oils which can reach the eastern and maritime provinces of Canada with a lesser burden of freight, per tanker, than from these remote western oil fields. Lines now moving oil northward to the Great Lakes may, in time, be reversed to move Canadian oils southward.

It has been estimated that about 1 billion barrels of new oil reserves are in sight in Alberta, with every prospect that this total may be increased from two- to four-fold if exploration work is carried on at its present pace. This reference is to Alberta, alone, exclusive of the adjoining province of Saskatchewan, where basic geological conditions are favorable, and where the political climate is believed to be improving to such an extent that many strong U. S. and Canadian oil companies are acquiring acreage in substantial blocks.

Western Canadians are witnessing a great land play, as is indicated in part by the fact that two sections of Crown lands in the new Redwater Field have been sold at auction for more than $3 million each. Royalite Oil Company, Ltd,. a subsidiary, recently sold and divorced by Imperial Oil, paid $3,153,491 for Section 15, now fully developed, and Amerada Petroleum Corporation in mid-June paid $3,223,320 for Section 16.

For the immediate future, however, Alberta is entering a period which threatens to be relatively dull, insofar as exploitation, or drilling for production, is concerned. Local crude production now exceeds refining capacity and prairie market demand, as sharply delimited by railroad freights. Two dozen drilling rigs have been stacked in proven fields, and several local drilling contractors are looking for new locations, while others are arriving steadily from the U. S.

Job-Seekers Excluded

The Canadian Immigration Service has excluded U. S. job-seekers looking for work in Canadian oil fields; and U. S. citizens already here, or who may be admitted later, may face the cancellation or non-renewal of their entry permits, if and when Canadians can be trained to take their places. This ruling, which may be enforced elastically with regard to the ebb and flow of the local labor market, virtually excludes the lower echelons of oilfield workmen, while admitting necessary managerial talent such as foremen, highly-trained specialists, and other experts, including drillers, if unemployed canadians are not available for such duties.

Meanwhile, exploratory work, core drilling, geological and seismic surveys, geophysical reconnaissance, wildcat drilling, leasing, buying, and trading, etc., will continue unabated over regions greater than the whole Mid-Continent and Gulf Coastal areas of the U. S., with big oil companies of Canada and the U. S. and a few from Europe scrambling for acreage and position. A feature of the present situation is that Imperial Oil and others holding more acreage than can be tested with their own equipment, personnel, and resources during the terms of their exploration permits are "farming out" portions of their lands to late-comers and others qualified to make suitable tests by drilling.

Recently, there were 72 geophysical and gravity meter crews working in Alberta, with numerous surface geological parties, core drilling parties, and 82 active drilling rigs, of which about one-half are engaged in wildcat prospecting. Such efforts have turned Alberta and Saskatchewan into the most active hunting grounds for oil in the world, as Canada is receiving much of the attention which, on account of adverse political conditions, has been diverted from Latin America and the Near and Far East.

1000-Mile Pipe Line

Interprovincial Pipe Line Company, Ltd., newly chartered pipe line subsidiary of Imperial Oil, Ltd., which in turn is a subsidiary of Standard Oil Company (N.J.), is going ahead with plans for the immediate construction of about 450 miles of 20-inch line from the new fields around Edmonton, Alberta, to the prairie refining center of Regina, in Saskatchewan, with other plans being formed for the early extension of a 16-inch line 500 miles in length from Regina to Fort William, or some other point at the head of the Great Lakes, whence oil can be transported in lake tankers to the refineries at Sarnia, Chicago, and elsewhere on lake water. It is contemplated that the whole new system of approximately 1000 miles, costing about $100 million, may be completed by the end of 1950, or shortly thereafter, at which time oil from Alberta may find entry into established channels now serving the rich markets of Central Canada and the Middle Western regions of the U. S.

Pipe of the larger diameter for the first leg of the new system is expected to be supplied by U. S. mills, while pipe of the smaller diameter is to be supplied by Canadian mills. Steel for this purpose is now being converted into slabs at Hamilton, Ontario, to be rolled in Canadian mills.

A Federal Pipe Line Act was passed by the last session of the Dominion Parliament, which also passed a special act incorporating the Interprovincial Pipe Line Company, Ltd., with an authorized capitalization of $200 million and granting to it authority to build pipe lines between provinces, subject to the approval of the Board of Transport Commissioners. This Board sanctioned the new project June 11. Federal authorization of the new system on an inter-provincial basis gives to it certain paramount rights and advantages such as those associated with inter-state trade in the U. S.

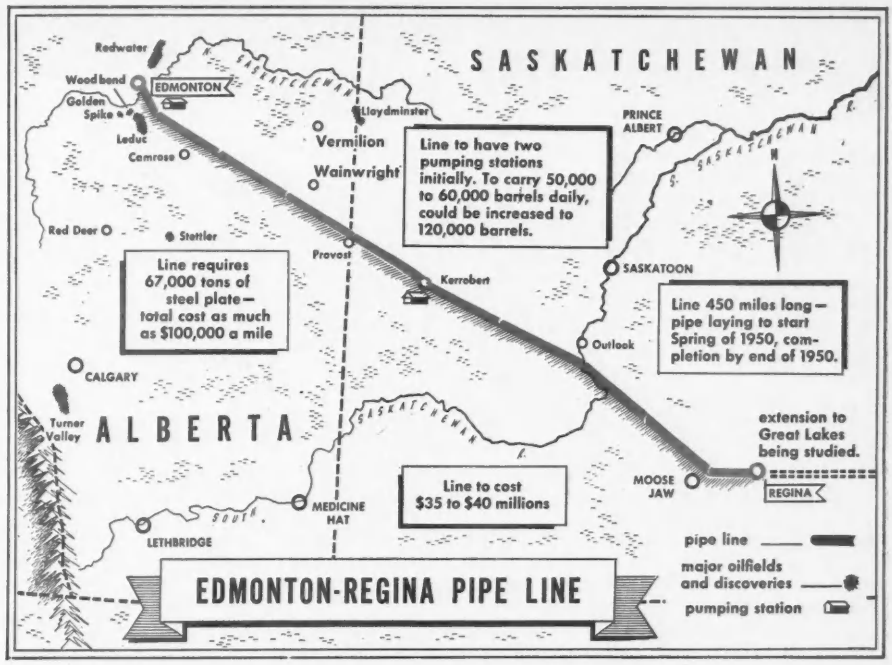
J. R. White, vice president of Imperial Oil, and a director of the new pipe line subsidiary, declared recently that the new line will be operated as "a common service to all producers in the area." Imperial Pipe Line Company, Ltd., which operates gathering lines in the Leduc and Redwater fields, is purchasing ratably from all producers in those areas, even though it is not a common carrier.

Route of Line

The new trunk line will take a general southeasterly course from Edmonton to Regina, passing through Provost, on the inter-provincial boundary, and Outlook, Saskatchewan, which is on the South Saskatchewan River, about 50 miles south of Saskatoon.

This construction will more than triple Canada's total mileage of trunk pipe lines, now consisting of 236 miles of 12-inch running from Portland to Montreal, to save the long ocean haul around the Maritimes and up the St. Lawrence River, and of three loops of six- and eight-inch lines running from Cygnet, Ohio, to Sarnia, where Imperial's refining activities are centered. Gathering lines run short distances from Turner Valley to Calgary, and from Leduc-Woodbend to Edmonton.

Dr. O. B. Hopkins, a vice president and director of Imperial Oil, has been named president of the new Interprovincai Pipe Line Company, Ltd. He is a former member of the U. S. Geological Survey, and later was active in the evaluation of the de Mares Concession, Colombia. He became chief geologist for Imperial in 1921, vice president in 1944, and was elected a director in 1945. Other officers and directors of the pipeline subsidiary are also officers of Imperial Oil Limited. They are F. C. Hall, vice president and director, R. D. Murray, and secretary, K. A. Henderson, treasurer. J. R. White, A. E. Halverson, C. D. Crichton, and R. B. Burgess all of Toronto, complete the board of directors.



Western Canadian oil, now more than sufficient for prairie requirements, will find its way to larger markets by means of a pipe line, first of its kind in Canada. The map shows the first stage of the line, from Edmonton to Regina. Under active consideration is the early extension of the line to the Great Lakes, a step which might lead to construction of a larger line between Edmonton and Regina than was originally planned.

H. Lem Stevens Guille, formerly president and manager of Madison Natural Gas Company, Ltd., of Calgary, and more recently a member of Imperial Oil's producing department in Toronto, has been placed in charge of Interprovincial Pipe Line Company's operations in Edmonton, the western starting point of the new system. A native of England and holding a bachelor of science degree in oil engineering and refining from the University of Birmingham, he started in Canada as a roughneck at Turner Valley, whence he rose through such positions as chemical engineer in the gasoline plant of Royalite Oil Company, Ltd., at Turner Valley, and field superintendent and later president and manager of Madison Natural Gas Company, Ltd., of Calgary. He joined Imperial Oil in 1947 and has since been engaged in engineering duties in a senior capacity in the Western Producing department.

Meanwhile, some degree of relief may be afforded to producers in the new oil fields of this province by the continued enlargement of Imperial's "most travelled refinery in the world," which during the war was moved from Corpus Christi, Texas, to White Horse, in the Yukon Territory, and, afterward, to Edmonton. The recent addition of a second crude distillation unit will raise its capacity from 11,000 to 15,000 or 16,000 barrels throughput per day. Futhermore, Imperial's refining capacity at Regina, which was cut back to 7000 barrels per day by a disasterous fire, has been rebuilt and repaired so as to restore its rated capacity of 15,000 barrels per day. These additions and reconstructions will add 11,000 or 12,000 barrels per day to the demand for Alberta crude.

Voluntary proration has been adopted as a self-regulatory action among producers in the newer fields, such as Leduc, Woodbend, and Redwater. They have agreed to restrict production from the various zones of the several fields, with allowables currently ranging from 75 barrels per well per day from D-2, or Upper Zone, wells at Leduc, to 125 and 135 barrels per day in the nine months old field at Redwater. Other allowable rates, within these limits of 75 to 135 barrels per well per day, are applied in other zones, with certain variations according to needs of the different purchasing companies. So for, there are only two purchasers of crude oils from the new fields: Imperial Oil Limited and British-American Oil Company, Ltd., who are moving oil by rail to refineries in Alberta and Saskatchewan. Posted prices for light oils, such as are produced from these new fields, now range around $3 per barrel, with higher prices ruling at Turner Valley, where output is restricted in accordance with gas-oil ratio, and which has a pipe line outlet to Calgary.

Mexican Oil Loan

Negotiations Suspended

NEGOTIATIONS between the U. S. and Mexico on the proposed Export-Import Bank loan to Mexico for the development of the Mexican petroleum industry have collapsed.

The amount of the proposed loan was reported to range between $450 million suggested by the House Interstate and Foreign Commerce (Wolverton) Committee, and $100 million reportedly the minimum favored by President Truman.

Late in July the announcement was made by the Mexican government and by the U. S. State Department that conversations on the grant had been "suspended," but the State Department said the proposed line of credit may be reopened for study at any time.

Reasons given by the State Department for suspension of negotiations:

1. It is the policy of the Export-Import Bank to grant loans for development purposes only where private capital is not available. The Department is not convinced that private capital is not ready to assume such risk in Mexico.

2. It does not favor a loan for exploration work, but only for bolstering Mexico's internal refining and distribution needs.

3. Mexico has not satisfied the U. S. that it has adequate production, now or in prospect, to supply refining and marketing projects covered in its request for the loan.

The Department emphasized that this policy is applicable to all foreign oil programs, including those of the Middle East.

Some industry observers seem to believe that the statement that the matter may be reopened for study at any time may mean that the loan, after being taken off the front pages of the newspapers, may be resumed in a less political atmosphere.

The collapse of negotiations closely followed protests by Max Ball, former head of the Oil and Gas division of the Interior Department, and by F. H. Porter, speaking for the Kentucky and Mid-Continent Oil and Gas associations, indicating a rising tide of opposition throughout the American petroleum industry.

Porter, in directing his remarks to the State Department, cited the failure of Mexico's monopoly to make a profit since expropriation in 1938, and did not see where such assistance would result advantageously to either Mexico or the U. S.

Also, said Porter, "there is no foreseeable emergency that requires the immediate development of new reserves outside the U. S.

Ball contended in his protest to the State Department that it is not vital that our additional sources of oil be in any particular country, even Mexico. "Canada, our neighbor to the north, offers more alluring prospects, geologically and politically, than Mexico."

Ball said: "Finding and developing Mexico's reserves is not a job for monopoly, whether state or private. The job calls for the interplay of a wide diversity of individual judgments. It can be be done successfully, in my opinion, only by competitive exploration, on terms offering adequate incentives for the cost and risk involved."

Slow Development

He reminded the State Department that Mexico's oil development has been virtually at a standstill for the past ten years. Mexico should have drilled 500 to 1000 wells every year to keep pace with comparable areas of the U. S., but its actual average has been only 35.

The job would require probably at least 10,000 wells; it might take 20,000 or more.

"Fewer wells are not likely to give proportionate results. In the early stages of exploration new oil is found in something like a geometric ratio to the number of wells drilled. The first wells are the most hazardous. Drilling 10,000 wells in Mexico would cost from $1 billion to $2 billion, depending on location, depth and prices for labor and materials. Field equipment, pipe lines, and the like would probably cost an additional $1 billion to $2 billion.

"In addition Mexico needs $20 million to $50 million to modernize her present refineries, build new ones and provide better internal distribution of products. Mexico does not have this capital available, let alone the $2 billion to $4 billion for exploration, development and transportation.

"Neither the interest of Mexico nor our own would be served by a poor loan. The government of the U. S. cannot afford to lend Mexico $2 billion to $4 billion for exploration and development. She does not lend to her own citizens for such purpose. If she were in the habit of making of making loans for exploration, the amount required is too large and the loan would not be good.

"The only probable source of the financing required is the American, British and Dutch oil companies. Only by opening the door to all of them can the necessary competition in exploration and development be obtained.

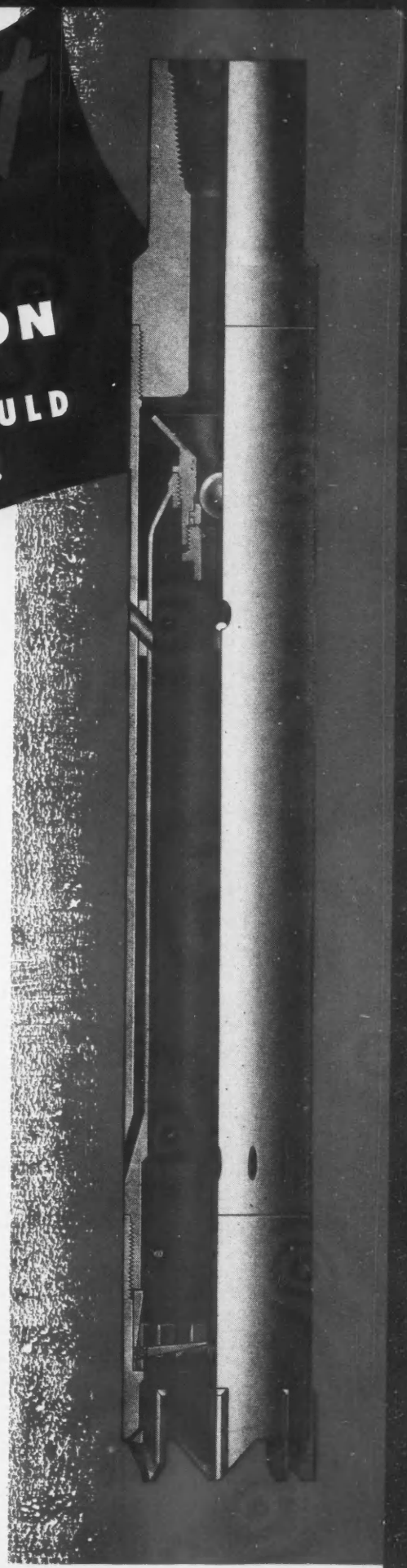
Meanwhile Mexico's development program gained some additional impetus during the early part of 1949. Well completions are running considerably ahead of the pace maintained during 1948 when but 82 wells were drilled, and reports from Mexico indicate that there has been some success in exploratory drilling.

During the first five months of the year 50 wells were completed, seven of which have been exploratory tests. One, known as the Francisco Cano 1, southeast of Reynosa in Northeastern Mexico, opened new production at a total depth of 5889 feet making 190 barrels of oil daily, and at least one other well, not yet completed, is reported opening a new field in the Isthmus district.

Press reports from Mexico indicate a new field with a high initial potential of high-gravity oil is being opened by Pemex Belem 6, in Macuspana, Tabasco, Isthmus of Tehuantepec. Spudded late in December, 1947, it was running a series of production tests at 6972 feet in early June, 1949. The newspaper reports refer to this well as Fortuna Nacional 1, and say that it produces at a rate of 1000 barrels daily from a horizon at approximately 5300 feet. The reports quoted Pemex officials as saying that a pipe line is already under construction to carry oil to El Rayo, from which point it is to be taken by river to the refinery at Minatitlan.

FOR *On The Spot* PROTECTION

THIS BOWEN JUNK BASKET SHOULD BE ON EVERY DRILLING RIG!



EVERY OPERATOR KNOWS the vital importance of "on the spot" protection for his drilling well. He can't afford to risk his investment without it!

That's why the Bowen Junk Basket is a handy tool to have on your rig while drilling. It's instantly ready to run in to pick up lost bit cones, tong pins, hammers, mill cuttings and similar junk . . . to straighten a hole at point of drift . . . or to recover a core!

REVERSES FLUID FLOW

Unlike ordinary junk baskets, the Bowen uses reverse circulation to *pull* objects into the basket—not force them away. Circulating fluid is diverted outwardly and downwardly through side passages in the barrel and against the full circumference of the hole. Here it is deflected in a manner that pushes all objects toward center. Fluid flows in a continuous stream to the center of the tool and up through it to return ports, giving a reverse circulation action without disturbing regular circulation in the well. *Moreover, full pump pressure can be utilized*—a feature that's exclusive with the Bowen Junk Basket—because there's no danger of pressure bearing against and causing loss of the fish!

In addition to junk recovery, the Bowen Junk Basket is widely used as a hole straightener and for coring purposes. It's available in sizes from 4 5/8" to 17 1/2", and is engineered to recover all types of bit cones within its various size ranges. For details—call the Bowen Service Store in your territory or write for descriptive literature.

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British, U.S. Leaders Fear:

ECA Dollars May Start Oil Price War

By HENRY OZANNE
Staff Writer

TOP level discussions between the British and the U. S. governments have been held over British oil industry expansion with the aid of American dollars and the possibility of a price war and a battle for world petroleum markets that would hit a hard blow at both the British and American industries.

The conversations in Washington were held between representatives of the Economic Cooperation Administration and Keith Stock of the Petroleum Division of the British Ministry of Fuels and Power. The issues turned on ECA aid to finance expansion of European-owned (chiefly British) crude production by 52 percent in the next three years and an increase of European refin-

European Petroleum Equipment Program
National Submissions for Fiscal Year of 1949
(In thousands of dollars)

	Drilling Equipment		Well Casing		Refining Equipment		Stoage Equipment		Pipeline		Miscellaneous, Including Fees; and Transport and Distribution Equipment		Grand Total		
	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Total
Austria	50	0	0	0	0	0	0	0	0	0	0	0	50	0	50
Belgium—Luxemburg	0	0	0	0	540	694	0	0	0	0	2,246	254	2,786	948	3,734
France and OT's	1,487	1,940	0	2,400	3,913	12,200	0	6,000	25	7,800	3,460	33,360	8,885	63,700	72,585
Germany: Bizone	2,250	5,520	0	7,600	6,030	7,780	2,900	28,505	0	0	888	1,049	12,068	50,454	62,522
Ireland	0	0	0	0	0	0	122	287	0	0	148	1,236	270	1,523	1,793
Italy	1,009	195	0	0	3,496	1,500	35	0	0	0	1,074	0	5,614	1,695	7,309
Netherlands	0	0	0	0	8,698	340	125	995	0	0	755	849	9,578	2,184	11,762
Portugal	0	0	0	0	2,200	0	22	0	0	0	1,057	104	3,279	104	3,383
Turkey	1,110	0	0	0	0	0	0	0	0	0	0	0	1,110	0	1,110
United Kingdom	33,000	23,300	17,400	6,800	60,000	93,900	5,900	26,500	0	12,000	32,600	97,500	148,900	260,000	408,900
Total Europe	38,906	30,955	17,400	16,800	84,877	116,414	9,104	62,287	25	19,800	42,228	134,352	192,540	380,608	573,148

Notes—Equipment included under the heading "dollars" must be obtained almost entirely from the United States, whereas equipment shown under the heading "Non-dollars" is in general produced in the participating countries.

For the purpose of this table, estimates have been used as prepared by the participating countries; they include all equipment required by American companies operating in the participating countries and operating in joint ventures with British companies overseas.

The United Kingdom estimates include the overseas programs outside North America of British companies (including the Royal Dutch Shell Co.'s) and the French share of the Iraq Petroleum Co.'s program.

European Petroleum Equipment Program
National Submissions for Fiscal Year of 1950
(In thousands of dollars)

	Drilling Equipment		Well Casing		Refining Equipment		Storage Equipment		Pipe Line		Grand Total		
	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Dollars	Non-Dollars	Total
Belgium—Luxemburg	0	0	0	0	4,000	1,000	818	207	0	0	4,818	1,207	6,025
Denmark	0	0	0	0	900	0	0	0	0	0	900	0	900
France[1]	1,380	13,700	0	2,000	2,743	51,460	55	22,300	45	2,000	6,223	92,460	[2]98,683
Germany—Bizone	2,821	7,400	0	7,600	5,555	10,000	0	25,000	0	0	8,376	50,000	58,376
Greece	0	0	0	0	4,570	0	720	0	0	0	5,290	0	5,290
Iceland	0	0	0	0	0	0	0	400	0	50	0	450	450
Ireland	0	0	0	0	0	0	122	287	0	0	122	287	409
Italy and Trieste	5,625	0	0	0	26,828	3,960	705	0	200	0	33,358	3,960	37,318
Netherlands	0	0	0	0	2,022	290	0	938	0	0	2,022	1,228	3,250
Norway	0	0	0	0	400	600	0	0	0	0	400	600	1,000
Portugal[1]	5,118	794	0	322	1,609	619	3,440	871	0	0	10,167	2,606	12,773
Sweden	0	0	0	0	2,500	0	0	0	0	0	2,500	0	2,500
Turkey	5,000	0	0	0	0	0	0	0	0	0	5,000	0	5,000
United Kingdom[1]	33,800	29,800	13,800	7,200	73,000	121,200	9,400	31,000	2,400	38,800	132,400	228,000	360,400
Total	53,744	51,694	13,800	17,122	124,127	189,129	15,260	81,003	2,645	40,850	211,576	380,798	[3]592,374

[1] Data for France, Portugal, and United Kingdom include overseas programs.

[2] France. Totals include 2 million dollars from dollar sources and 1 million dollars from non-dollar sources for overseas territories, for which distribution by type of equipment is not available

[3] Totals include undistributed items described in footnote 2.

Notes—Equipment included under the heading "dollars" must be obtained almost entirely from the United States, whereas equipment hown under the heading "non-dollars" is in general produced in the participating countries.

The country total for fiscal 1950 apparently exclude certain items such as transportation and distribution equipment, which were included in the fiscal 1949 program.

For the purpose of this table, estimates have been used as prepared by the particiapting countries; they include all equipment required by American companies operating in the participating countries and operating in joint ventures with British companies overseas.

The United Kingdom estimates, totaling 360.4 million dollars, exclude certain local expenditures such as the cost of construction labor and tools, land acquisiton, insurance, supplies, etc., which, however, are included in the figure of 500 million dollars for total British investment in petroleum development, as cited on p. 79 of the United Kingdom Country Study, published in February 1949, by ECA.

The United Kingdom estimates include the overseas programs outside North America of British companies (including the Royal Dutch Shell Co.'s) and the French share of the Iraq Petroleum Co.'s program.

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SPLIT MASTER BUSHING: Cast steel. Takes A.P.I. Standard drive bushings. Master bushing alone or both master and drive bushings can be locked to table.

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ing capacity by 33 percent during the same time.

The conferences were mapped after British oil officials themselves expressed fear that measures taken by the British government to save dollars would drive American companies out of some markets with the prospect of likely reprisals against sterling markets. One British oil executive said Britain's savings in dollars would be offset by her loss in dollar earnings, and a disastrous world competitive fight in oil would follow.

Obvious Dangers

American oil economists concede that to some extent ECA has helped prevent the loss of some petroleum markets to U. S. companies by providing dollar help for Europe's oil requirements. However, the danger to U. S. world petroleum trade has been highlighted by several recent developments, such as British trade agreements with Egypt and Argentina by which Britain agrees to furnish Egypt $20 million dollars worth of petroleum, and the $80 million meat-for-oil deal with Argentina. These trade pacts are designed to avoid giving Egypt and Argentina sterling convertible into dollars and thus imposing further drain on British dollar reserves.

One of the key issues raised in the Washington conference is the threat to the American industry in the huge British refinery expansion program. The United Kingdom has under way a refinery construction program to increase by eight times its refining capacity. Concerning these plans ECA has warned:

"These plans do not represent a well-balanced oil economy. Based on them Europe in fiscal 1953 would have available 59.6 million tons of crude oil, 57.5 million tons from imports plus 2.1 million from domestic production.

"European consumption between fiscal 1949 and fiscal 1953 is expected to increase by more than 15 million tons. Since current requirements for refined products can be satisfied on the basis of existing refining capacity, the difference between the total expansion of capacity planned and the increased requirement for finished products in Europe, a difference of more than 41 million tons, would have to find an outlet outside of Europe. It is unlikely that the program is in line with future market possibilities."

Expansion Problem

The program for the expansion of crude production also presented a problem for the discussions. ECA has pointed out:

"It is interesting to compare the scheduled expansion in the overseas production of the European countries with total world production as estimated by the API report on availability. It is estimated that total crude oil production amounted to 130 million tons in 1947 and will rise to 240 million tons in 1953. In comparison, the overseas production of European countries in 1947 was 55 million tons, or 42 percent of total; in 1953 their overseas output will be 114 million tons, or nearly 48 percent of total production, outside the U. S., Russia and Europe.

"The large increase in production of the European countries is due to their relatively large share of Middle East production which is expected to show the greatest proportionate increase in world production during the period, about 150 percent, or more than 60 million tons between 1947 and 1953, as compared with an increase of 55 percent, or about 45 million tons, in the Western Hemisphere outside the U. S."

The accompanying tables are all from the "European Recovery Program" report by ECA, recently issued.

European[1] Refining Capacity, National Submissions

(In thousands of metric tons)

	Fiscal[2] 1953	Fiscal 1950	Fiscal 1949	1947[3]	1938
Austria	1,275	1,200[4]	1,200[4]	1,200	625
Benelux	8,360	3,915	2,960	1,700	1,500
Denmark	877	27	27	27	20
France	18,700	12,715	11,200	7,500	8,000
Germany (Bizone)	4,100	3,380	2,200	750	2,800
Germany (French)	40	40	40	40	n. a.
Greece	400	0	0	0	0
Italy, Trieste	9,885	5,290	3,410	3,000	1,500
Norway	35	0	0	0	50
Portugal	500	400	300	300	0
Sweden	1,600	1,150	550	550	60
Switzerland	90	90	90	0	0
United Kingdom	19,800	7,000	5,500	5,300	4,700
	65,662	35,207	24,477	20,367	19,255

[1] Estimates are for refining capacity, or for some countries, for crude oil throughput rates at the midpoint of each year.
[2] Preliminary estimates.
[3] Capacity as estimated for end of calendar year 1947.
[4] All refineries are located in the Russian zone.

European Crude Oil Supplies

(In thousands of metric tons)

	Fiscal 1953[1]			Fiscal 1950[1]			Fiscal 1949			1947			Prewar[2]		
	Production	Imports	Total	Production	Imports	Total	Production	Imports	Total	Production	Imports	Total	Production	Imports	Total
Austria	[3]555	0	555	[3]366	0	366	[3]350	0	350	[3]350	0	350	0	155	155
Benelux:															
Belgium[4]	600	5,771	6,371	0	400	400	0	302	302	0	220	220	0	269	269
Netherlands[4]	.....	.....	.....	600	2,914	3,514	595	1,742	2,337	213	1,037	1,250	0	754	754
Denmark	0	660	660	0	30	30	0	25	25	0	17	17	0	11	11
France	75	18,700	18,775	60	[5]10,227	10,287	50	8,091	[6]10,287	53	4,994	5,047	72	6,183	6,255
Germany:															
Bizone	750	2,000	2,750	650	1,550	22,00	575	690	1,265	262	38	300	445	365	[7]810
French Zone	7	28	35	0	28	28	0	28	28			Included with Bizone			
Greece	0	400	400	0	0	0	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20
Italy and Trieste	15	9,885	9,900	0	[8]4,289	4,289	0	3,265	3,265	0	1,732	1,732	15	1,500	1,515
Norway	0	35	35	0	0	0	0	0	0	0	0	0	0	17	17
Portugal	0	500	500	0	322	322	0	282	282	0	267	267	0	77	77
Sweden	0	1,500	1,500	0	1,150	1,150	0	900	900	0	525	525	0	92	92
Switzerland	0	30	30	0	30	30	0	15	15	0	0	0	0	0	0
United Kingdom[9]	102	17,976	18,078	112	6,196	6,308	112	4,985	5,097	146	2,412	2,558	120	2,230	2,350
Total Europe	2,104	57,485	59,589	1,788	27,136	28,924	1,682	20,325	22,007	1,024	11,242	12,266	652	11,673	12,325

[1] Preliminary country estimates as submitted to OEEC.
[2] 1938 or other representative prewar year.
[3] That portion of the domestic production which is likely to be available for the satisfaction of Austria's domestic requirements. Total 1948 production is estimated at about 900,000 tons.
[4] Netherlands combined with Belgium in fiscal 1953.
[5] Excludes about 1,500,000 tons of crude oil to be refined in France for the United Kingdom, and includes about 737,000 tons of crude to be refined in France for Algeria.
[6] Excludes approximately 800,000 tons of crude oil to be refined in France for United Kingdom and includes 601,050 tons of crude to be refined in France for Algeria.
[7] Excludes about 900,000 tons of synthetic petroleum products and substitutes.
[8] Excludes about 1,000,000 tons of crude oil to be refined in Italy for re-export.
[9] Production figures exclude an undetermined quantity of tar, benzol, and other synthetic petroleum production.

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Several well-known operators follow a policy of consulting Baroid field service engineers on drilling problems in a given area, *before* drilling starts. They profit by these pre-drilling consultations through reduction in drilling costs and by earlier and better completions.

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PATENT LICENSES unrestricted as to sources of supply of materials, but on royalty bases, will be granted to responsible oil companies and others desiring to practice the subject matter of any and/or all of United States Patent Numbers 2,041,086; 2,044,758; 2,064,936; 2,094,316; 2,119,829; 2,294,877; 2,387,694; 2,393,165; 2,393,173; 2,417,307 and further improvements thereof. Applications for licenses should be made to Los Angeles office.

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Afghanistan to Invite Aid of U. S. Oil Companies

AFGHANISTAN has indicated it will seek the aid of American oil companies for an intensive development of Afghan petroleum resources. A rapid industrialization program is under way in Afghanistan, the land-locked kingdom in Asia, which is hemmed in by Iran on the west, Russia on the north, Baluchistan on the south, and India on the east. Yet so primitive is the country that it still retains the character of a Biblical land. Across the Khyber Pass, the paved road stops at the frontier of Pakistan, and it is 800 miles of mountainous path from there to the Afghan capital, Kabul, in the range of the Hindu Kush.

At Kabul a number of American firms already are at work on the gigantic task of helping Afghanistan progress 2000 years to become a modern mechanized nation. The courtyard of the palace at Kabul has been converted into a construction camp occupied by the Morrison-Knudsen Company of New York, at work on storage and dam projects in the Helmand and Kabul river basins. The Americans are assisting these nomads transform their mud hut villages into new, modern towns.

Kabul itself is being completely torn up in the modernization effort. All the capital's streets are being paved at once, and the city has been rung with a string of electric lights.

Oil is scheduled to play a huge part in this transformation enterprise. Afghanistan is seeking a $60 million loan from the U. S. to take the first step toward carrying out plans already detailed by American surveys.

Previous Oil Search

The hunt for oil will not be Afghanistan's first. In 1936 Seaboard Oil Company, through its then existing subsidiary Inland Exploration Company, obtained a petroleum concession covering virtually all of Afghanistan. Even then Afghanistan believed it had valuable subsoil mineral deposits. When Seaboard, through another affiliate, Amiranian Oil Company, was negotiating a concession in Iran, the Afghan minister at Teheran prevailed on the American company to come to Kabul and the concession was signed there. Seaboard carried on survey work in Afghanistan from 1936 to 1938, and at one time had as many as four surface parties in the field. However, the job was difficult and first discoveries at Kuwait and Saudi Arabia caused Seaboard to relinquish rights in Afghanistan because of the difficulty of transporting oil even if it were found there.

Many industry geologists have long regarded Afghanistan as good prospecting territory, even though it has never been probed by the drill due to the geographic and economic isolation of the country. The area which Afghanistan believes is most promising in its projected oil development program lies just north of the Hindu Kush mountains that cross central Afghanistan in an east-west direction. A foothills belt gradually merges with the vast plains basin, where up to 15,000 feet of dominantly marine sediments of Cretaceous and Tertiary Age hold the hope of major discoveries.

Across the Orus River which constitutes much of the boundary between Afghanistan and Russia, the Soviets have developed the important oil fields of the Ferghana and Termez districts which lie in the same basin province and involve the same general geologic section.

Possibilities are also encouraging on the south side of the Orus as is demonstrated by the fact that a series of visible en echelon anticlinal structures extends across the area, paralleling the mountain trend. Further, active oil and gas seeps dot the region and the presumed reservoir rocks show residual oil at the outcrops in the mountains themselves.

The larger anticlines, adjacent to the foothills belt, may be expected to hold commercial pools in Lower Cretaceous sands. They are not too strongly folded or faulted, nor are they deeply eroded. Minor folds further northward under the plains, perhaps, offer the best possibilities. Little eroded, they also contain known oil sands in the higher Eocene beds.

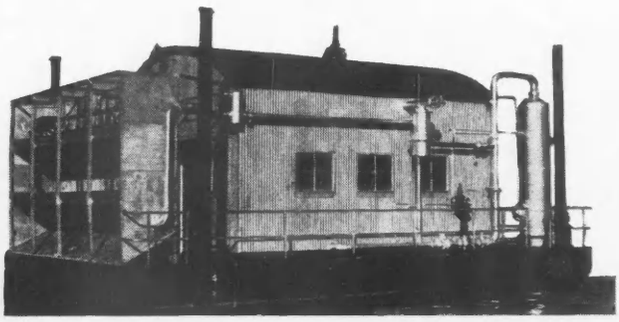
Discovery of oil in commercial quantity in Afghanistan would provide an important source for a huge potential market in Baluchistan, Pakistan, and India, one of the world's densest population areas. Petroleum products in this area now come from nearby refineries in Russia through an expensive procedure.

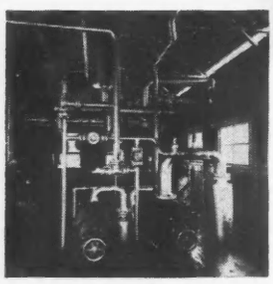
Afghanistan, unlike many Asian states, is in good financial position. At the end of World War II, the country had accumulated a dollar balance of $100 million, although most of this has now been spent. Caracul and wool exported to the U. S. yield a dollar income of $10 million to $20 million. Kabul officials have specified that the $60 million American loan would be broken down into two separate lines of credit, one for public resources development, the other for private enterprise.

ANOTHER NOTABLE "FIRST" BY Levingston

At Right — Compressor Barge being towed to location.

Below—Interior view of Barge showing compressor.





Compressor Barges for Gas Cycling or Transmission in Marine Fields

Here is another example of Levingston's leadership in the field of specialized marine equipment for the petroleum industry.

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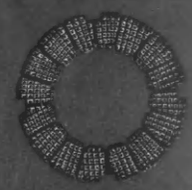

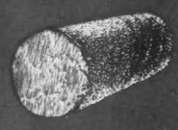

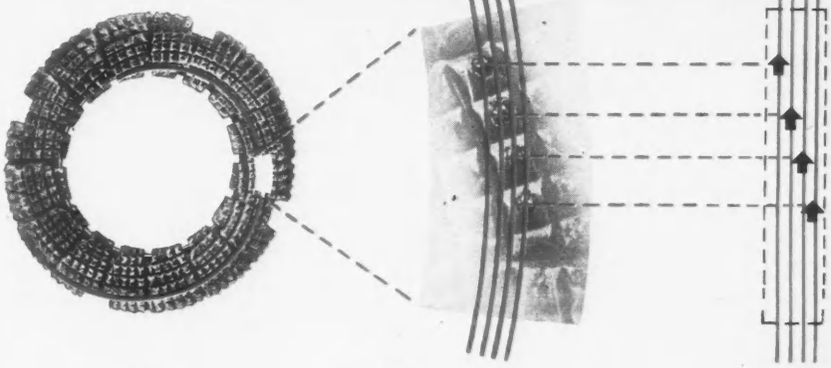

FIG. 1 FIG. 2 FIG. 3

Maximum cutting efficiency (bit cost per foot) in Core Lab Diamond Bits is obtained by expertly selecting and handsetting each stone in a scientifically diagrammed spiral pattern (Fig. 1). This design, assuring that not more than half of the leading edge of each diamond will cut the formation, results in—(A) a smooth shearing of the formation, as compared to an inefficient bouncing action which occurs if the entire leading edge of each diamond is allowed to meet the formation pointblank; and (B) longer bit usefulness through controlled diamond wear.

In Fig. 2, above, the concentric arcs represent the travel path of the diamonds as the bit rotates, while the "Spiral-Set" pattern causes each diamond to assume a specific position with respect to adjacent stones and to carry a uniform "work load." The efficiency of the spiral pattern is further exemplified by direct comparison with the cutting principle of a gang plow (Fig. 3).

All Core Lab "Spiral-Set" Diamond Bits are manufactured with this same precisioned uniformity. Core Lab Diamond Core Barrels, incorporating both standard and improved operating features, *plus* Core Lab's field-proven reputation as one of the industry's top hands in *service*, add up to your best bet for Diamond Coring Equipment and Service.

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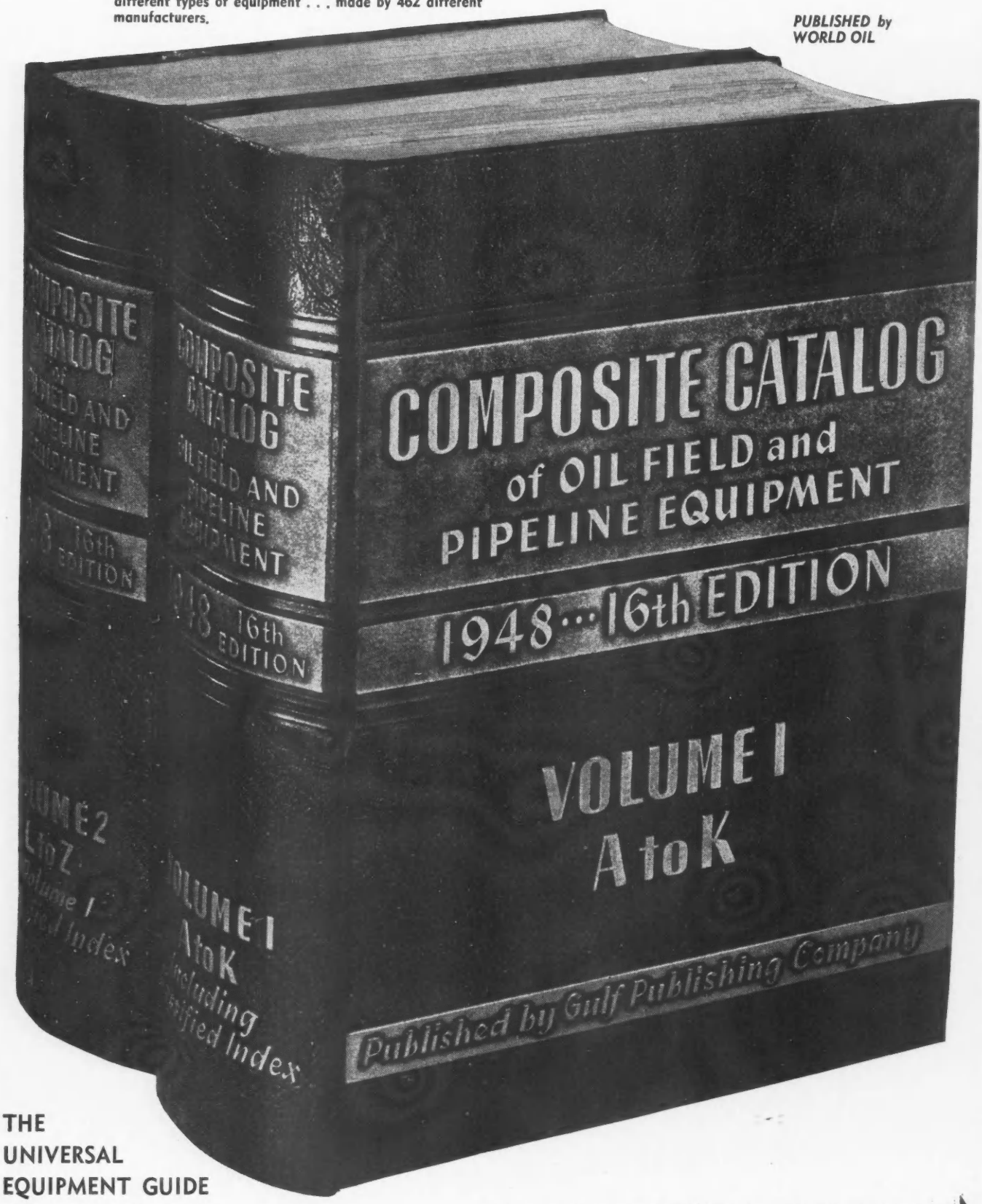

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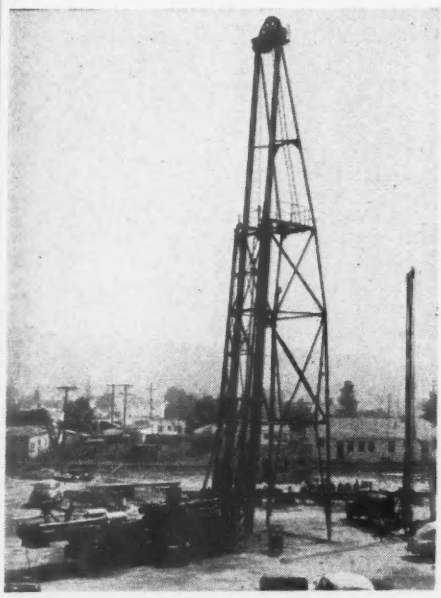
NEW AND IMPROVED Equipment SUPPLEMENTING COMPOSITE CATALOG

New and improved equipment of manufacturers who describe their products or services in the current Composite Catalog

205—Hydraulic Rig

This item supplements M. O. Johnston Oil Field Service Corporation data as shown on pages 2053-2076 of Composite Catalog.

Two models of what eventually will be a complete line of hydraulic type drilling and production rigs, were shown for the first time last month by the Johnston Hydraulic Rig Company. Displayed at the Los Angeles plant of the M. O. Johnston Oil Field Service Corporation, the rigs represent a considerable departure from conventional rigs in that drawworks and traveling blocks are eliminated, the hoisting action being obtained by hydraulically actuated pistons which travel up and down inside smooth bore cylinders, the latter also serving as derrick or mast legs. The wire line attached to the load is run up over the large diameter crown block and down through the cylinders where it is attached to the pistons. Hydraulic power is supplied by pumps mounted on the rig chassis.



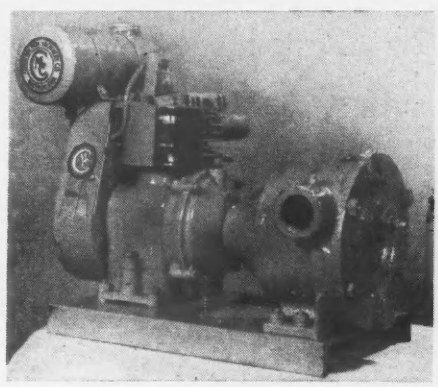
One of the new rigs is a trailer-mounted unit with a drilling depth capacity of 5000 feet using 4½-inch drill pipe or a load of 100,000 pounds. Shown in the photograph, this unit has four principal legs, the two inner ones being the hydraulic power cylinders. When extended, the mast from mat to top of the sheave guards stands 93 feet, 5 inches high. Collapsed, over-all length of the mast in the horizontal position is 62 feet, 11 inches. The two outer legs, pipe rack platform and bracing are designed to fold inward and lay flat against the inner portion of the rig when it is collapsed for over-the-road travel. The mast is designed to withstand a maximum load of 150,000 pounds. Maximum travel of the hook is 70 feet. The crown block sheaves are 60 inches in diameter, the unusually large size of which is expected to materially increase the working life of the wire line. The rig is powered by two 170 horsepower diesel engines. Fuel tanks and hydraulic fluid reservoirs are mounted in the frame of the trailer chassis.

The second unit, that designed for well pulling service, already has been put into service in the field, and results of field testing have been satisfactory. The unit employs only one cylinder, which also serves as the pole mast. Powered by a 95-horsepower, V-8 type engine, this rig has a rated pulling capacity of 2500 feet of 2½-inch tubing or 5000 feet of one-inch rods. Maximum pull at the hook is 28,000 pounds. Clear height of the mast, which can be laid back over the unit for over-the-road travel, is 49 feet. Size of the wire line is one-inch. Crown sheave is 24 inches in diameter. Maximum hydraulic pressure developed in the cylinder is 465 pounds per square inch.

For additional information, write M. O. Johnston Oil Field Service Corporation, 3035 Andrita Street, Los Angeles 41, *referring to* WORLD OIL *item* 205.

206—Rotary Pumps

This item supplements Construction Machinery Company data as shown on page 1077 of Composite Catalog.



Pumps engineered to facilitate the recirculation of liquids such as crude are available in two models. Model RF1-125 is a 1¼-inch pump which handles 20 gallons per minute at 40 pounds pressure, and RF2-125, also a 1¼-inch unit, pumps 20 gallons per minute at 80 pounds pressure.

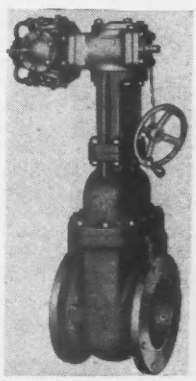
Both models of Roto-Flo positive displacement pumps are self-priming.

For additional information, write Industrial Pump division, Construction Machinery Company, P. O. Box 120, Waterloo, Ia., *referring to* WORLD OIL *item* 206.

207—Fluid-Motor Operator For Valves

This item supplements Crane Company data as shown on pages 1086-1087 of Composite Catalog.

A fluid-motor operator for gate valves can be adapted to standard valves in stock or to valves already installed. It can be operated by water, oil or compressed air or gases.



The motor unit, comprising the motor, gear box and yoke, is bolted to the valve bonnet, and the motor operates the valve stem through the gear box. The motor derives its power from five flexible diaphragms, mounted radially about an eccentric on the drive shaft. Operating fluid is admitted in rotational sequence to the five diaphragms, which actuate pistons that transmit the thrust to the eccentric through a roller bearing mounted on the shaft. By means of a suitable control, the operating fluid can be admitted through either of two entrance ports, controlling the direction of operation of the motor for opening and closing the valve.

The valves can be operated by a wide range of liquids or gases at pressures from 40 to 300 pounds per square inch. The operating mechanism delivers a high starting torque and is adjusted to deliver a greater torque for unseating the valve than for seating it. A handwheel is furnished for manual operation in the event of pressure failure.

Valves equipped with the new fluid-motor operator are available in sizes four-inch through 30-inch.

For additional information, write Crane Company, 836 South Michigan Avenue, Chicago 5, *referring to* WORLD OIL *item* 207.

PENBERTHY
REFLEX and TRANSPARENT
DROP FORGED STEEL
LIQUID LEVEL
GAGES

PENBERTHY
REFLEX
Drop Forged Steel
Liquid Level Gage
Empty Space Shows White
Liquid Shows Black

Due to "Reflex" principle, liquid always shows black and empty space white. Liquid level is indicated instantly and unmistakably. Made of temperature resisting alloy steel for high pressure and temperature service. Conforms with API and ASME requirements.

PENBERTHY
TRANSPARENT
Drop Forged Steel
Liquid Level
GAGES

Glass front and rear permits observation of color and density of liquids under high pressures and/or temperatures. Highest quality—made of temperature resisting alloy steel. Conforms with API and ASME requirements.

3277-C

PENBERTHY PRODUCTS

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant—Windsor, Ontario

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

208—Centrifugal Pumps

This item supplements Byron Jackson Company data as shown on pages 797-896 of Composite Catalog.

Refinement of appearance and simplification to provide access for maintenance and lubrication were incorporated in the re-design of Deepwell centrifugal pumps.

Pumps may be selected for varying well diameters, capacities and heads. Three assembly sizes fit wells from 6 to 24 inches, or larger. Several impeller designs are standard for each size in each of the three bowl types and provide more than 100 individual impeller designs of varying hydraulic characteristics.

For additional information, write Byron Jackson Company—Pump Division, Terminal Annex, Box 2017, Los Angeles 54, *referring to* WORLD OIL *item* 208.

209—Rotary Pump

This item supplements Worthington Pump and Machinery Corporation data as shown on pages 4387-4406 of Composite Catalog.

A mechanical seal and a self-lubricating type inboard sleeve bearing on a new line of rotary pumps, known as GAMI, is employed to carry overhung drives. Seal and bearing assembly are interchangeable on the same shaft with the standard stuffing box of the GA type pump, so that if service conditions change, substitutions of seal or stuffing-box can be made.

The seal is subject to suction pressure only, and has been found tight even at high vacuum.

The new line, suited to installations requiring high vacuum and a drip-proof construction, is designed for handling liquids comparatively free from abrasive or corrosive substances, and is capable of handling a considerable amount of air or gas in the liquid. The new pumps are regularly used for handling liquids of various viscosities from tar and heavy oils to light liquids such as gasoline and kerosine.

For additional information, write Worthington Pump and Machinery Corporation, 426 Worthington Avenue, Harrison, N. J., *referring to* WORLD OIL *item* 209.

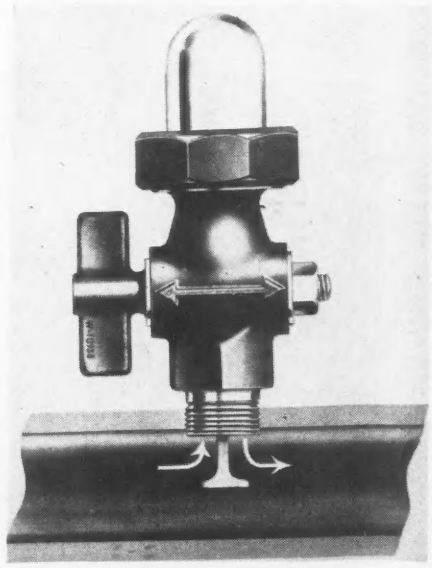
210—Sight Glass

This item supplements Worthington Pump and Machinery Corporation data as shown on pages 4387-4406 of Composite Catalog.

The clarity or turbidity of transparent liquids flowing under pressure through pipe lines can now be observed by means of a valve-type sight glass.

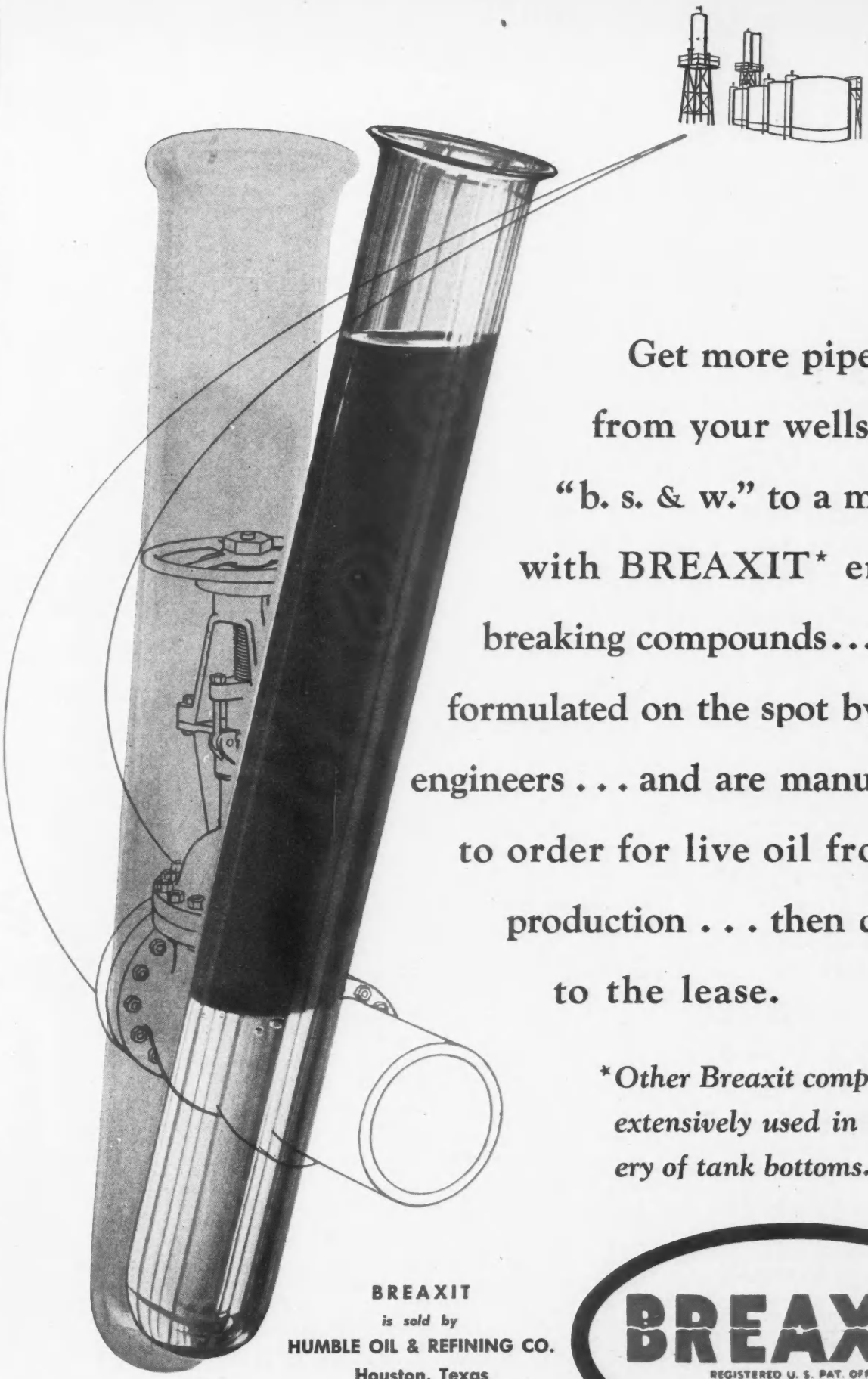
Differential pressure is established across the deflector to allow some of the liquid to circulate continuously through a glass observation bowl. A valve permits removal of the observation bowl for cleaning.

Originally designed for observing the clarity of hot water passing through hot process water treating systems, the valve type sight glass can be used in



any system through which transparent liquids flow.

For additional information, write Worthington Pump and Machinery Corporation, 426 Worthington Avenue, Harrison, N. J., *referring to* WORLD OIL *item* 210.



Get more pipe line oil from your wells . . . Cut "b. s. & w." to a minimum with BREAXIT* emulsion breaking compounds . . . they are formulated on the spot by trained engineers . . . and are manufactured to order for live oil from your production . . . then delivered to the lease.

Other Breaxit compounds are extensively used in the recovery of tank bottoms.

BREAXIT
is sold by
HUMBLE OIL & REFINING CO.
Houston, Texas

For quick service, wire or write.

BREAXIT
REGISTERED U. S. PAT. OFF.

DIAMOND CORING

brings...
✓SPEEDIER PENETRATION
and...
✓GREATER RECOVERIES

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DIAMOND OIL WELL
DRILLING COMPANY
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MIDLAND, TEXAS
Phone 2710

PARKERSBURG MACHINE Co. PARMACO PARKERSBURG, W. VA. U.S.A.

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EXCLUSIVE EXPORT DISTRIBUTOR
PETROLEUM MACHINERY CORP.
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

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use
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★ More Efficient!
★ Quicker Acting!
★ More Economical!

See Your Supply House for Parmaco Products

PARKERSBURG
MACHINE
COMPANY
PARKERSBURG, W. VA.

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

211—Chain Couplings

This item supplements Morse Chain Company, Division of Borg-Warner Corporation, data as shown on pages 2782-2785 of Composite Catalog.

A single connecting pin design has been adopted for Morse DRC stock double roller chain couplings. The single connecting pin design simplifies assembly and disassembly of the couplings.

The seven sizes available range in capacity from 2-7/10 to 97 horsepower per 100 revolutions per minute, and are in a wide range of finished bores.

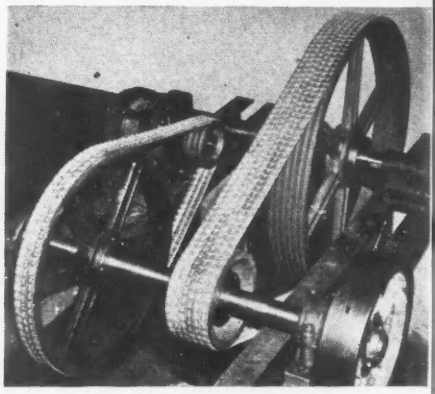
For additional information, write Morse Chain Company, 7601 Central Avenue, Detroit 8, Mich., *referring to* WORLD OIL *item* 211.

212—Belting

This item supplements Worthington Pump and Machinery Corporation data as shown on pages 4387-4406 of Composite Catalog.

Specially designed to service emergency breakdowns, Vee Ply belting can be adapted to most V-belt drive applications, such as on drives requiring dismantling a part of the machine to install endless belts.

The belting reduces over-all inventory by eliminating the need to carry a spare set of endless belts for every machine. It is uncoupled from roll stock as needed and is adjustable to any length. There are no waste ends.



It is flexible and presents no problem of internal friction, thus maximum horsepower ratings are accomplished at minimum sheave diameters.

For additional information, write Multi-V-Drive Sales Division, Worthington Pump and Machinery Corporation, P. O. Box 953, Buffalo 5, N. Y., *referring to* WORLD OIL *item* 212.

BOWEN REMOVABLE
SWIVEL ROPE SOCKETS

FOR SWABBING AND BAILING

Split Liner Type

These handy rope sockets prevent a fire hazard as they can be babbitted away from a well. They can be removed from the line without cutting the line or melting the babbitt.

The split liner type allows the babbitted line to pass through the Inner Assembly of Bowen Automatic Line Wipers and the solid liner in the other model will pass through the crown blocks.

Both models may be fitted for ½", 9/16" or ⅝" line and are 1⅝" O.D. Connection is 1-1/16" O.D., A.P.I. Sucker Rod Pin.

Also made in other popular sizes.

Complete instructions are furnished with each socket. Catalog with detailed information will be furnished promptly when requested. See Bowen Co. of Texas' Section 1948 Composite Catalog.

Solid Liner Type

Through Supply Stores anywhere in the U.S.A.

BOWEN CO. of TEXAS, INC.

Office: 2429 Crockett St., P. O. Box 1025, HOUSTON 1, TEXAS, Phone A. 8-4568
Odessa, Texas, Phone 789—Oklahoma City, Phone 6-8087—
Midland, Texas, Phone 1439—Houma, La., Phone 6709

KONTOL

DEVELOPED and MANUFACTURED by the TRETOLITE COMPANY

COMBATS SUB-SURFACE CORROSION OF PUMPING EQUIPMENT

- CUTS CORROSION RATE
- PROLONGS PUMP SERVICE
- INCREASES TUBING LIFE
- REDUCES ROD FAILURES
- STOPS PITTING
- EASY TO USE
- ECONOMICAL

KONTOL Corrosion Preventives were developed and are manufactured by Tretolite. Conveniently applied by periodic dumping or pumping down the well annulus, they adsorb strongly to the metal surfaces of pumping equipment. KONTOL has been exhaustively tested on gas, gas-condensate, sweet crude and sour crude wells in Texas, New Mexico, Kansas, Illinois, Wyoming and California.

Why not insure maximum life for your pumping equipment? For further particulars, or full details about the KONTOL rate of corrosion test service, write or call the Tretolite Company. No obligation, of course.

SEND FOR THE NEW KONTOL INFORMATIONAL BOOKLET

TRETOLITE COMPANY

Manufacturing Chemists

ST. LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

G-49 -2

213—Pipe Wrap

This item supplements Owens-Corning Fiberglas Corporation data as shown on page 3317 of Composite Catalog.

Known as Coromat, a new high-strength Fiberglas wrap for underground pipe lines is a porous mat of glass fibers reinforced with long, continuous strands of glass yarns.

Yarns are made of fine, flexible, textile-type filaments of glass designed to resist soil acids and electrolytic action. By incorporating the high-strength yarns in a multi-directional pattern, the tear strength of the basic pipe wrap has been increased 200 to 400 percent.

High tear strength permits application at high speeds without the delays caused by breakage of the wrap. With breakage eliminated, 1000 or 1200-foot rolls can be used, doing away with frequent machine stoppages to add new rolls.

For additional information, write Owens-Corning Fiberglas Corporation, 1833 Nicholas Building, Toledo 1, Ill., *referring to* WORLD OIL *item* 213.

SPEEDS UP
Tank Car Turnaround
New Unit Eliminates
Scraping, Brushing, Steaming Out

Pictured is the Oakite Interior Tank Cleaning Unit. With it you can cut tank car cleaning time 75%. That's not all! Cleaning is *so thorough* that you can ship light oils, distillates in cars that previously carried crudes or asphalt.

With this kind of high-speed efficiency in interior tank car cleaning you minimize turnaround delays through faster cleaning . . . you are assured greater availability of tank cars.

This powerful cleaning unit, leased to Oakite users, eliminates costly hand-brushing and scraping. Does its cleaning mechanically by hitting tank car interiors with rotating sprays of hot-detergent solution. Steaming out of cars is entirely eliminated.

You can obtain complete operational details on the unit merely by writing address below. Ask for new, illustrated pamphlet. No obligation.

OAKITE PRODUCTS, INC., 37 Thames St., NEW YORK 6, N. Y.
Technical Service Representatives in Principal Cities of U. S. & Canada

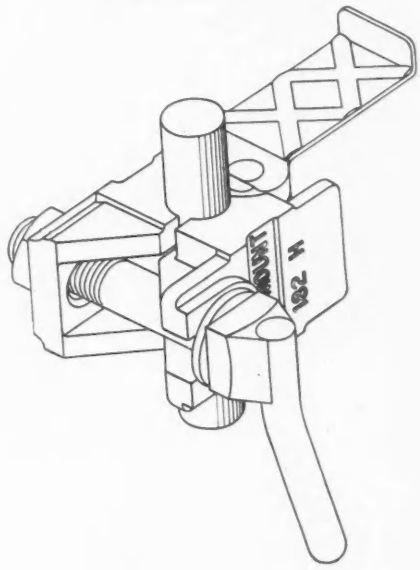
OAKITE 1909 1949 40th ANNIVERSARY YEAR

OAKITE
TRADE MARK REG. U. S. PAT. OFF.

PETROLEUM SERVICE DIVISION

214—Polished Rod Grip

This item supplements Paramount Equipment Company, Inc., data as shown on page 3326 of Composite Catalog.



New polished rod grips come in single units which are hinged on one side and close with a high-tensile bolt on the other. Since the bolt need never be removed from the grip when applying or removing it, there are no loose parts to handle or mislay.

Single grip units are machined on top and bottom so they may be applied in combinations of two or more, according to the needs of the well load. Thus when a heavy well is closed down, the compounded grips may be removed and redistributed to other wells of lighter load.

One model, the "Spiro" grip, serves also as a non-marring or crushing wrench for rods and rod liners.

Included in the line is a safety-step grip, shown, which is fastened by a wing nut. The step is integral with the grip, and offers a safe step for the operator. This grip, by reversing the bolt and tightening with a wrench, may also be used to pump, space, or clamp off wells.

The grips are available in alloy aluminum, malleable iron, or electric steel, to fit all sizes polished rods.

For additional information, write Paramount Equipment Company, Inc., P. O. Box 901, Tulsa, *referring to* WORLD OIL *item* 214.

Announcing

DAILY FLIGHTS TO VENEZUELA

DIRECT ROUTE TO VENEZUELA-JAMAICA-CUBA

from

NEW ORLEANS and HOUSTON

Chicago & Southern Air Lines announces the inauguration of *daily* flights to and from Venezuela, in answer to the growing public demand. C&S 4-motored Douglas Skymasters now provide seven-days-a-week service linking South America with the oil and industrial area of the Southwest. Direct, one-carrier flights through the Houston and New Orleans gateways to Caracas—each way every day. Ask your travel agent or nearest C&S ticket office for details.

CHICAGO & SOUTHERN AIR LINES

GENERAL OFFICES . . . MEMPHIS, TENNESSEE

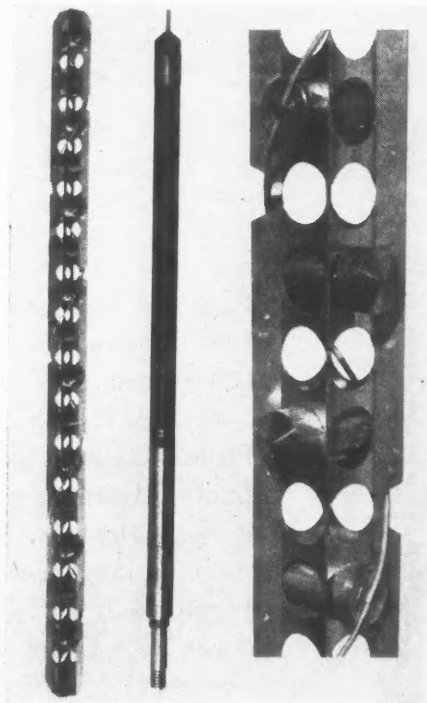
C★S

OTHER NEW AND IMPROVED *Equipment*

217—Torpedo Jet Process

Run in the well by standard Welex perforating equipment, the torpedo jet is a shaped charge sealed in an aluminum cylindrical case. These aluminum cases are inserted into an aluminum carrier as shown, They can be spaced on six-inch centers and spiralled around the carrier on 90-degree phasing, 180-degree phasing or all charges faced in one direction. The charges are detonated electrically from the shooter's control panel. Explosive compounds used are insensitive to shock and heat, and are safely handled and transported in the same manner as jet perforator units.

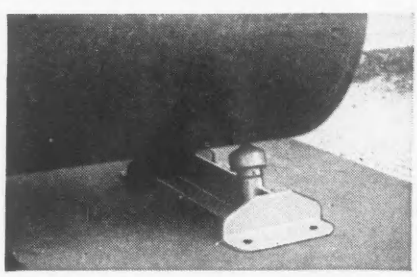
Upon detonation, each jet charge produces a large, tapering hole approximately 1½ inches in diameter and up to 30 inches deep depending upon formation hardness. It produces radial fissuring and cracking around the circumference



of each hole, thereby opening large drainage areas and securing the maximum advantages from existing vertical permeability. Blasts from fragments of the cases at high velocities thoroughly scour the face of the formation. The tremendous forces generated with the Torpedo-Jet are accurately controlled and directed into the formation. Effect of the blast is negligible on areas above or below the selected zone.

For additional information, write Welex Jet Services, Inc., 3909 Hemphill Street, Fort Worth 9, *referring to* WORLD OIL *item* 217.

218—Pipe Line Dolly



For movement of pipe in both yard installations and field operations, a new pipe line dolly consists primarily of two large, heavy duty steel balls, supported by ball bearings, mounted in a welded, light-weight steel framework.

Construction of the ball type supports and casters permits rotation or endwise movement of pipe on the dolly. The ball mechanism is shielded from foreign matter, permitting use of the dolly under adverse field conditions.

For additional information, write Reed Engineering Company, Carthage, Mo., *referring to* WORLD OIL *item* 218.

For WIRE LINE CORING

Be Sure IT'S A KING *Be Safe*

USE

KING 4C CIRCULATING HEAD AND 4AR WIRE LINE STRIPPER

The King 4C Circulating Head and 4AR Wire Line Stripper are companion tools and best results are obtained when they are used together. When used together, they are so compact as a unit, that pipe can be raised and lowered with short bail elevators.

KING 4C CIRCULATING HEAD

The King 4C Circulating Head has a 3" clear opening through it. The spindle can be furnished for any commonly used tool joint pin. The top of the circulating head has a 4" female pipe thread, and the gooseneck a 3" female pipe thread. Bearings are sealed in the housing with a grease nipple provided.

KING 4AR WIRE LINE STRIPPER

The King 4AR Wire Line Stripper is an automatic release type, having a positive latch and a sure release. Bronze rollers guide the line and are equipped with grease nipples for lubrication. Rubber strippers are inserted from the sides and can be renewed while the line is in the hole. This tool is non-sparking which lessens the fire hazard.

For Swabbing Use KING Type 3AR Wire Line Stripper

See Composite Catalog for other King Oil Tools.
All prices F.O.B. Houston, Texas, and subject to change without notice.

Complete details upon request. Order through Your Supply Store.

Export: R. S. STOKVIS & SON, Inc.
17 Battery Place, New York 4, N. Y.

KING OIL TOOLS

210 TERMINAL STREET PHONE WO-8013
HOUSTON 20, TEXAS

Diana Lynn says...

"I like The Shamrock because...

DIANA LYNN
Soon to be seen in the Hal Wallis Production;
"My Friend Irma."

...it is to me the epitome of good living and unlabored hospitality. I think this is most evident the moment you enter The Shamrock's breathtakingly beautiful lobby . . . for then you immediately sense the aura of cordiality that helps make you, the 'stranger,' feel so welcome. Being somewhat of a devotee of smart interior decorating, I can really appreciate the lobby's eye-arresting decor . . . a really superb combining of elegance and comfort. And speaking of comfort, it reaches grand new heights in those wonderful, individually air-conditioned rooms! Yes, The Shamrock's my home on my every visit to Houston."

In Houston, you are cordially invited to live at

The Shamrock

America's Magnificent Hotel
A GLENN McCARTHY ENTERPRISE

● *Single rooms from $6 up*

Photo: courtesy Standard Oil Co. (N. J.)

✓ Check these

"PLUS" Features...

reasons for POWERFLEX leadership!

POWERFLEX Rotary Hose has these *plus* features which mean continuing oil field leadership:

- ✓ Tube—Synthetic rubber, abrasion and oil resistant.
- ✓ Reinforcement—Steel cables and pre-tested fabric for the greatest strength and flexibility.
- ✓ Cover—Special formula resists aging and abrasion.
- ✓ Couplings—Streamlined steel built in as an integral part of the hose—eliminates hose breakage behind the couplings—anchored securely for the life of the hose.
- ✓ Pre-testing—Every length is pre-tested to 5,000 psi.

The highest quality materials, modern precision manufacturing equipment and extra care in manufacture are additional *plus* features which guarantee POWERFLEX performance.

POWERFLEX available with male API threads. 2½" (3" thread), 3" and 3½" (4" thread). At your nearest oil field supply store!

It will pay you to *Specify* Thermoid!

Thermoid Quality Oil Field Products: Oil Country Flat Belting • Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All types of Hose • Molded Specialties • Powerflex Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • Brake Blocks • F. H. P. and Multiple V-Belts.

Thermoid Company

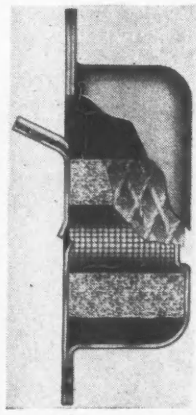
Western Offices and Factory • Nephi, Utah, U.S.A.

Main Offices and Factory • Trenton, N. J., U. S. A.

Industrial Rubber Products • Friction Materials • Oil Field Products

OTHER NEW EQUIPMENT

219—Oil Filter



Consisting of a stamped housing with a replaceable filter element, a transmission oil filter can be attached to all transmissions equipped with standard SAE six bolt short length power take-off openings. The six capscrews used to attach the power take-off cover plate can also be used to attach the new oil filter to the opening.

Transmission oil is forced into the filter housing and through the filter under pressure developed by the rotation of the transmission gears and shafts. As the oil is forced through the filter, foreign matter suspended in and circulating with the oil is deposited on the replaceable filter element and in the sump at the bottom of the housing. The clean oil is then channeled back into the transmission case.

The preferred position for mounting of the filter is on the right side of the transmission housing where the power take-off opening is standard short-length, six-bolt type. It should be used where the countershaft gears adjacent to the power take-off opening are of sufficient diameter to build up the pressure required to force the oil through the filter assembly.

For additional information, write Transmission division, Fuller Manufacturing Company, 3400 Fulco Street, Kalamazoo, Mich., *referring to* WORLD OIL *item* 219.

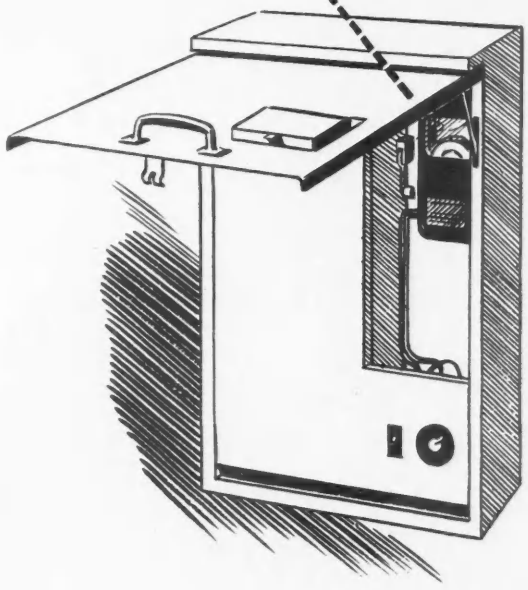
220—Ring Seal

A new type of protection for sensitive pressure recorders and indicators is the "O" Ring Seal, made for installation in the line between recorder outlet and measuring element. The seal is designed to protect all types of gauge elements from corrosion, clogging and shock of pulsations.

Type H of the seal is engineered for operating pressures from 0-500 up to 0-20,000 pounds per square inch, and can be used where mud, acids, corrosive mediums and heavy viscous fluids are present, without the risk of clogging or corroding the measuring element. It acts as a pulsation dampener and can be used on vacuum.

For additional information write Industrial Instrument Company of Odessa, Odessa, Texas, *referring to* WORLD OIL *item* 220.

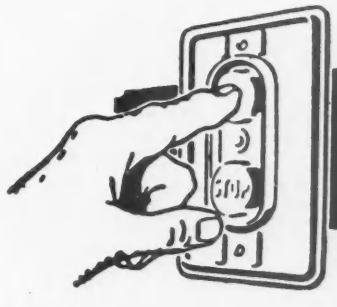
"SMARTEST THING the Company ever did!"



Yessir, it was a good day for me — and for the Company — when the lease was electrified. I looked after the lease alone while the wells were flowing. Now that they're pumping, electric power enables me to get the production by myself.

I can really rely on that time clock — I simply set the hours I want the wells "on" and "off" and they pump that way — month after month.

I see the power bills, too. They prove definitely that it's smart . . . and ***economical*** . . . to switch to electric power.



HOUSTON LIGHTING & POWER COMPANY

221—Air Compressors

A new selection chart, based on normal applications handling air with atmospheric intake pressure, simplifies selection of proper size compressor for average industrial use. Shown are comparison between discharge pressure pounds per square inch gauge, piston displacement cubic feet per minute, and recommended compressor bore and stroke in inches.

For a copy of the chart, write Worthington Pump and Machinery Corporation, Publications Department, 426 Worthington Avenue, Harrison, N. J., *referring to* WORLD OIL *item* 221.

222—Diesel Power Units

Series 71 diesel units equipped with G.M. torque converter are described in a new bulletin. Three, four and six-cylinder engines are described, with specifications and standard, optional and accessory equipment listed. Sectional views show dimensions, and charts illustrate torque characteristics, horsepower and efficiency, and power unit performance.

For a copy of this bulletin, write Detroit Diesel Engine Division, General Motors Corporation, 13,400 West Outer Drive, Detroit 28, *referring to* WORLD OIL *item* 222.

223—Junk Snatchers

A hydrostatic multiple-action junk fishing tool that runs with drill pipe or tubing is described in a four-page, two-color bulletin. Basic principle of the Multi-Surge Junk Snatcher is explained with drawings, and other illustrations and diagrams show the assembly of the tool. Engineering data and parts list are included in the folder.

For a copy of this bulletin, write The Cavins Company, 2853 Cherry Avenue, Long Beach 6, Calif., *referring to* WORLD OIL *item* 223.

224—Speed Reducers

Directions for selecting speed reducers of the horsepower and speed required are given in a new 44-page bulletin, No. 449. Included in the brochure are descriptions of units of the single and double reduction types, specifications, horsepower rating tables, overhung load capacities, dimensions and weights.

For a copy of the bulletin, write Farrel-Birmingham Company, Inc., 344 Vulcan Street, Buffalo 7, N. Y., *referring to* WORLD OIL *item* 224.

225—Steel Alloy

Properties of ESCO Alloy 20, an anti-corrosion stainless steel used in a new line of pipe fittings, are described in Bulletins 165-A and 166. The austenitic stainless steel is especially resistant to nitric-sulfuric acid mixtures, and contains sufficient nickel to hold the copper in solution, which is essential for resistance to sulfuric acid. Chromium and molybdenum contribute additional resistance to oxidizing acids.

For copies of these bulletins, write Electric Steel Foundry Company, 2141 N.W. 25th Avenue, Portland 10, Ore., *referring to* WORLD OIL *item* 225.

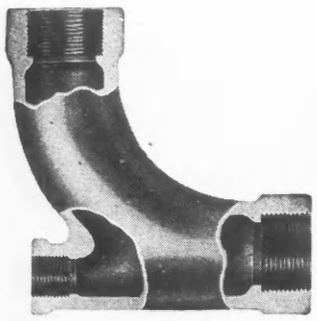
226—Transmission Systems Fittings

An unusual method of solving important pipe line construction problems is presented in Bulletin 492, "New Main Line Fittings for Gas Transmission Systems." In question-and-answer form, the 24-page booklet describes a new approach in providing for directional changes in pipe line work. Specifications for "Tanj-ells," from 8⅝ to 36 inches outside diameter, are given in table form.

For a copy of this bulletin, write Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, *referring to* WORLD OIL *item* 226.

For high pressure mud service . . . it's Big Four

HIGH PRESSURE FITTINGS



LONG SWEEP ELLS

For making turns in high pressure mud lines, the Big Four Long Sweep Ell reduces frictional losses and will stand up where ordinary fittings cut out. Side outlets are provided for release lines, mud mixing and other purposes.

Big Four Long Sweep Ells are made in 3" and 4" sizes with 2", 3" and 4" side outlets; also available are 3" to 4" Ells with 3" or 4" outlets. All are recommended for working pressures up to 3000 p.s.i.

STANDPIPE GOOSENECK

The Big Four Standpipe Gooseneck is used for making the return bend on top of the standpipe. When service and safety are considered, it is more economical than ordinary tees, ells and nipples . . . long turning radius reduces frictional losses and reduces cutting action of the mud and *there are no screwed connections in the bend* to work loose and cause trouble.

Available in 3" and 4" sizes and in 3" to 4" size. Recommended for 3000 p.s.i. working pressure.

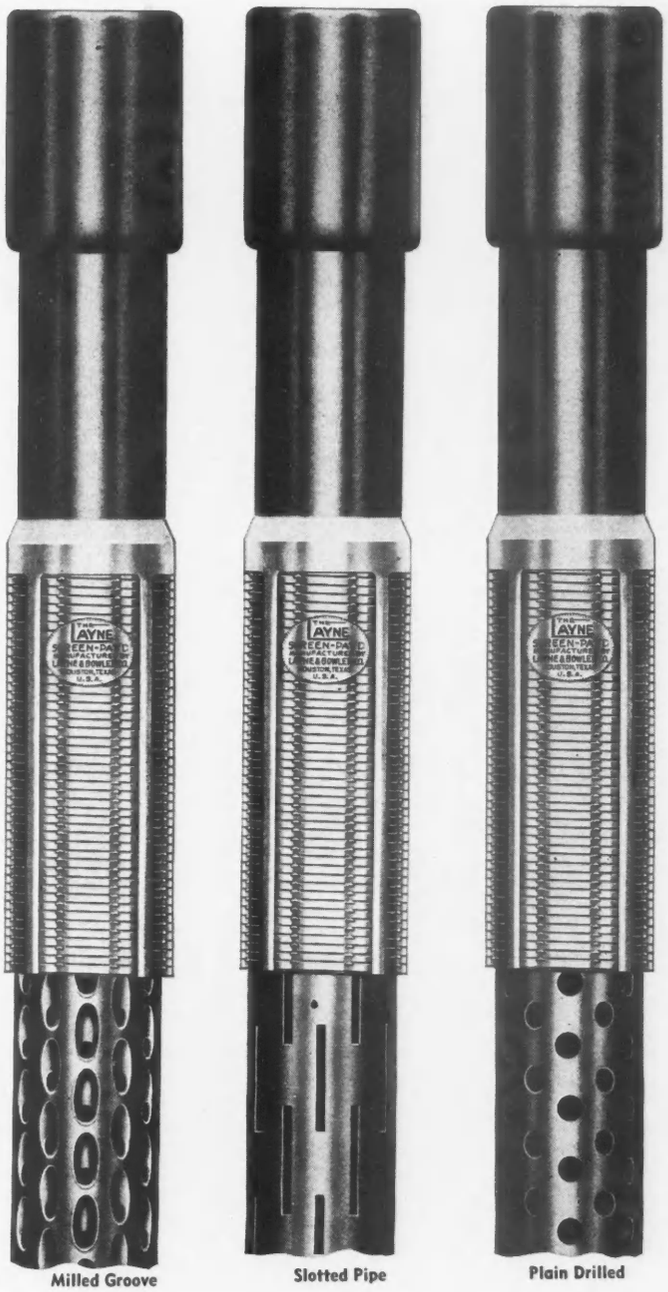
BIG FOUR MACHINE & SUPPLY COMPANY

BIG FOUR MACHINE and SUPPLY COMPANY

CLAY CITY, ILLINOIS, BOX 256
PAWHUSKA, OKLA., BOX 477

Manufacturers of BIG FOUR (Brauer) PRODUCTS

C & W Machine Works Company is authorized distributor for the entire state of Kansas for all BIG FOUR MACHINE & SUPPLY COMPANY (Brauer) Products. All C & W manufactured items and Big Four products are available here for distribution through supply stores.



Milled Groove | Slotted Pipe | Plain Drilled

THE LAYNE Wire Wrapped SCREEN

ADAPTABLE TO EVERY SAND PROBLEM

When you need a screen you need the best—and it should be especially adaptable to your particular sand problem.

In the Layne Screen you have the choice of three openings: milled groove, plain drilled, or slotted. Each has its place in the field. Regardless of the openings desired, each Layne Screen is precision made with accurate and uniform openings between the wires —the lugs accurately sized.

Remember the Layne patented wire wrapped Screen has earned its leadership through performance.

Remember

You can make one trip into the hole do the job of two by using the Layne Tubing Set Packer.

Write for Complete Information

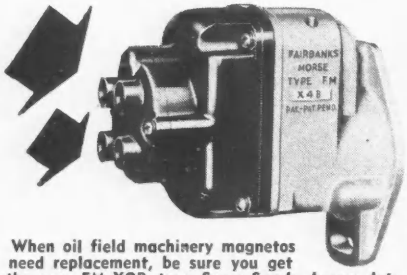
THE LAYNE AND BOWLER COMPANY

EXPORT:
Jeff Tucker
Room 1636
30 Rockefeller Plaza
New York, N. Y.

General Office & Factory
8000 Market Street Houston, Texas

WEST COAST:
Layne & Bowler Corp.,
900 Santa Fe Ave.,
Los Angeles, Calif.

Improved SUPER-SPARK MAGNETOS
for OIL FIELD EQUIPMENT



When oil field machinery magnetos need replacement, be sure you get the new FM-XOR type Super-Spark, heavy duty magneto. Greatly improved performance with longer-life breaker mechanism, larger bearings, improved magnetic rotor and timing facilities.

Available for 1, 2, 4 and 6-cylinder small, medium and heavy duty engines, this new FM-XOR type supersedes the former FM-J magneto.

See your nearest service station or write for details.

FAIRBANKS, MORSE & CO.
Magneto Division Beloit, Wis.

HOUSTON LABORATORIES
Analytical and Consulting Chemists
Podbielniak Gas Analyses, Oil Field Brines, Waters, Cores, Muds, etc. Reservoir equilibria studies for crude and condensate wells.
LD 267—Box 132 Houston, Texas

Standco
NO-SMOKE
STANDCO BRAKE LINING
Stands the gaff and gets the job done without scoring brake rims. See pages 3973-3978, Composite Catalog.
Standco Brake Lining Co.
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Consulting Geologist and Geophysicist
AERIAL MAGNETIC AND MICROMAGNETIC SURVEYS AND INTERPRETATIONS
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Gravity Surveys
COASTAL OIL FINDING COMPANY
Established 1928
ESPERSON BLDG. HOUSTON, TEXAS

Trading Post Ahead
PAGE 308

Associations

GEOLOGICAL SOCIETY BUILDS—The Kansas Geological Society, Wichita, Kansas, is among the first local geological society in the country to build its own permanent quarters. The new building, which was recently dedicated, will facilitate the distribution of well logs and samples to all members of the oil industry. Members of the society's Building Committee are, left to right, Don W. Payne, president of the society; L. C. Hay; Harvel E. White, manager, Kansas Well Log Bureau and Kansas Sample Bureau; and E. Gail Carpenter, chairman of the Building Committee.

Industrial Ad Group Chooses Waddell as Vice President

Milford R. Waddell, industrial and public relations director for Black, Sivalls & Bryson, Inc., was elected a vice president of the National Industrial Advertisers Association at the annual convention in Buffalo, New York. He was also appointed membership chairman for the coming year.

Milford R. Waddell

As vice president, Waddell will represent the Central Middle West on the executive board of NIAA. Waddell was a charter member and first president of the Kansas City Chapter of NIAA, organized in 1948, and for the second successive year he has been elected to represent the chapter on the national board of directors.

World Petroleum Congress At The Hague to Be in 1951

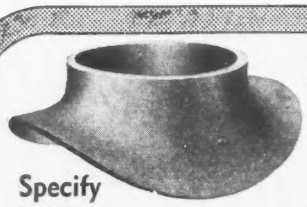
The third "World Petroleum Congress" will be held in the Netherlands during May or June, 1951. The first Congress was held in London in 1933 and the second in Paris in 1937. The third Congress will be organized by the Petroleum Section of the Netherlands Royal Institute of Engineers.

The secretariat is established at 30, Carel van Bylandtlaan, The Hague, to which address the names of those who propose to attend the Congress should be sent. A circular giving full particulars will be forwarded to interested parties in due course. The Congress will last one week. It has been decided that French and English shall be the official languages.

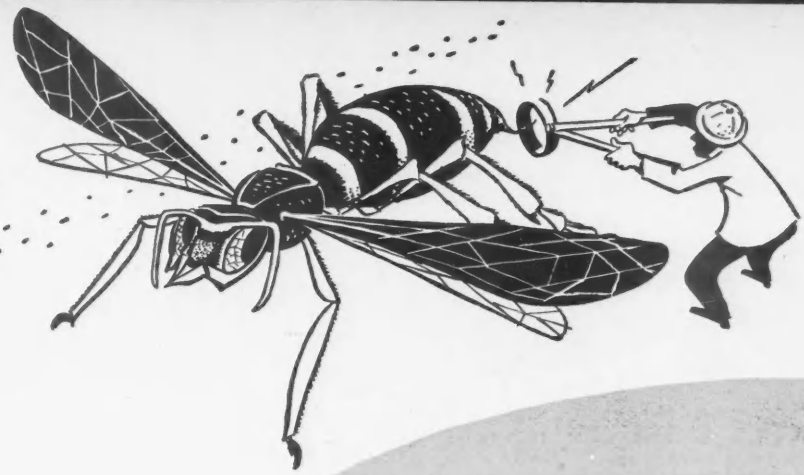
The purpose of the Congress is to provide an opportunity for the scientific discussion of all technical subjects appertaining to the petroleum industry or allied to it.

Conservation Group Elects

Lot Bowen, Western Gulf Oil Company, was elected chairman of the Conservation Committee of California Oil Producers. Other officers chosen are T. W. Bell, The Texas Company, first vice chairman; Ross McCollum, National Oil Company, second vice chairman; and Henry F. Power, General Petroleum Corporation, secretary.



PELCO
Welding Saddles
Specify PELCO
IMMEDIATE DELIVERY
OUTLET (OR NOZZLE) SIZES ¼" TO 16"
HEADER (OR LINE) SIZES UP TO 36"
Order Through Your Favorite Supply House
PELICAN WELL TOOL & SUPPLY CO.
P. O. Drawer 1108 Shreveport (84), La.



TAKES THE "STING" OUT OF LINER CEMENTING

BROWN

LINER CEMENTING METHOD

gives you complete control of the cement— you always know where it is!

For the first time, you can cement liner without dangerous errors in calculated displacement or locating cement.

Through complete control of the movement of the cement, THE BROWN METHOD OF LINER CEMENTING has overcome the weaknesses of customary liner cementing procedure, to effectively remove the "sting" of bad liner jobs.

The Brown Method of Liner Cementing employs two plugs. The first, a liner wiper plug, is secured to the liner setting tool stem by shear pins. The second, a pump down plug, is supported in the Brown Duplex Cementing Head until ready to drop with the top of the cement column.

The Brown FLOAT-N-FILL shoe used on the lower end of the liner will substantially reduce running-in time. A landing collar for the pump down plug is placed in the string as close to the shoe as desired, and the proper length of liner interposed between liner hanger and landing collar. Scratchers and centralizers can be used in the usual manner.

The FLOAT-N-FILL shoe allows the string to be filled from the bottom with properly conditioned mud as rapidly as conditions permit.

As soon as sufficient cement has been pumped into the hole, the Pump Down Plug is released, following the cement down the hole and marking the top of the slurry at all times. When contacting the liner plug on the setting tool stem, the slip ring on bottom of the Pump Down Plug engages the liner plug, which is indicated immediately by an increase in pressure on the gauge at the surface. At approximately 750 lbs. over circulation pressure the pins shear and the two plugs move down the liner, forcing the cement ahead of them. The plugs wipe the liner clean of cement down to the landing collar.

When the plugs bump the landing collar a rapid rise in pump pressure is registered, indicating the cementing operation is complete.

The two plugs latched in the landing collar form a back pressure valve to prevent the back-flow of cement into the liner when the pump pressure is removed. Radial strain on the liner is thereby eliminated while cement is setting.

Due to the bridging effect of the two plugs reverse circulation can be carried on and excess cement pumped out of the hole without applying pressure to the formation.

Numerous liner cementing jobs have been successfully completed by the Brown Method. Full details will be furnished on request. Write, Brown Oil Tools, Inc., Sales Office, State National Bank Bldg., Houston 2, Texas. Export Sales: Acme Well Supply Co., 19 Rector St., New York 6, New York.

BROWN OIL TOOLS, INC.

ASME Nominates Officers To Be Elected in December

James D. Cunningham, president of Republic Flow Meters Company, of Chicago, is the 1950 nominee for president of The American Society of Mechanical Engineers. He heads a slate of new officers, including four regional vice presidents and two directors-at-large, submitted by the nominating committee during the society's semi-annual meeting in San Francisco. Since the committee presents only one name for each office, nomination is tantamount to election.

Formal election will take place in the fall by letter ballot of the membership. The new officers will begin their terms at the end of the ASME annual meeting in New York next December. Cunningham will succeed James M. Todd, consulting engineer of New Orleans.

Regional vice presidents nominated are Frank M. Gunby (renomination), Charles T. Main, Inc., Boston; Professor John C. Reed, head of Mechanical Engineering department, Bucknell University, Lewisburg, Penn.; Albert C. Pasini, assistant superintendent, Production department, Detroit Edison Company, Detroit; Samuel H. Graf, director, engineering experimental station, Oregon State College, Corvallis, Ore.

Nominated as directors-at-large were Thomas E. Purcell, general superintendent, power stations, Duquesne Light Company, Pittsburgh, and Benjamin P. Graves, director of design, Brown & Sharpe Manufacturing Company, Providence, R. I.

REPUBLIC NATIONAL BANK
of DALLAS

STATEMENT OF CONDITION JUNE 30, 1949

RESOURCES

Cash and Due from Banks	$105,219,281.94
U. S. Government Securities	70,433,247.82
State, Municipal and Other Securities	3,018,717.16
Stock in Federal Reserve Bank	750,000.00
Loans and Discounts	135,215,978.29
Bank Premises and Equipment	2,212,781.55
Real Estate for Bank Expansion	1,291,959.54
Customers Liability—Acceptances & Letters of Credit	1,298,624.13
TOTAL	$319,440,590.43

LIABILITIES

Capital	$12,000,000.00	
Surplus	13,000,000.00	25,000,000.00
Undivided Profits		2,560,916.05
Reserve for Dividend, Payable July 1, 1949		240,000.00
Reserve for Contingencies		1,732,960.80
Reserve for Taxes, etc.		1,417,292.47
Acceptances and Letters of Credit		1,298,624.13
Deposits:		
Individual	$203,510,781.22	
Banks	81,700,852.26	
U. S. Government	1,979,163.50	287,190,796.98
TOTAL		$319,440,590.43

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Penn Grade Association Elects Streeter President

C. E. Streeter, Bradford, Penn., oil producer, was elected the 11th president of the Pennsylvania Grade Crude Oil Association at a board of directors meeting which followed the association's 26th annual meeting. He succeeds D. T. Ring of Columbus, Ohio, association president since 1946.

C. E. Streeter

Other officers chosen are George J. Hanks, president of South Penn Oil Company, Bradford, first vice president; and James D. Berry, Jr., "D" Oil Company, Oil City, Penn., second vice president. Re-elected were Fayette B. Dow, Washington, D. C., vice president and general counsel; Samuel Messer, president of Quaker State Oil Refining Corporation, Oil City, treasurer; assistant treasurers W. R. Reitz, Quaker State Oil Refining Corporation, Oil City, and C. L. Suhr, chairman of the board of The Pennzoil Company, Oil City; and W. C. Wenzel, executive manager.

Streeter is an officer and director of the Wellsville, N. Y., firms of Bradley Producing Corporation and Empire Gas and Fuel Company, Ltd. He is also a director of Texas Gulf Producing Company, Houston. He has been a director of Penn Grade since 1938.

New directors of the association are D. O. Laycock, Washington Oil Company, Taylorstown, Penn., and J. R. Corbett, Cato Oil & Grease Company, Oklahoma City. Ralph T. Zook, Bradford, a former president of the association, was elected an honorary director and member of the association for life.

Wyoming Landmen Organize

Frank P. Castleberry, The Atlantic Refining Company, was elected president of the new Wyoming Landmen's Association, which is comprised of land representatives of 21 companies operating in the Wyoming area. Other officers are H. E. Thomson, Amerada Petroleum Corporation, first vice president; Hal Thompson, British American Producing Company, second vice president; Tom Hunt, H. L. Hunt Oil Company, secretary; and Art Culver, Argo Oil Company, treasurer.

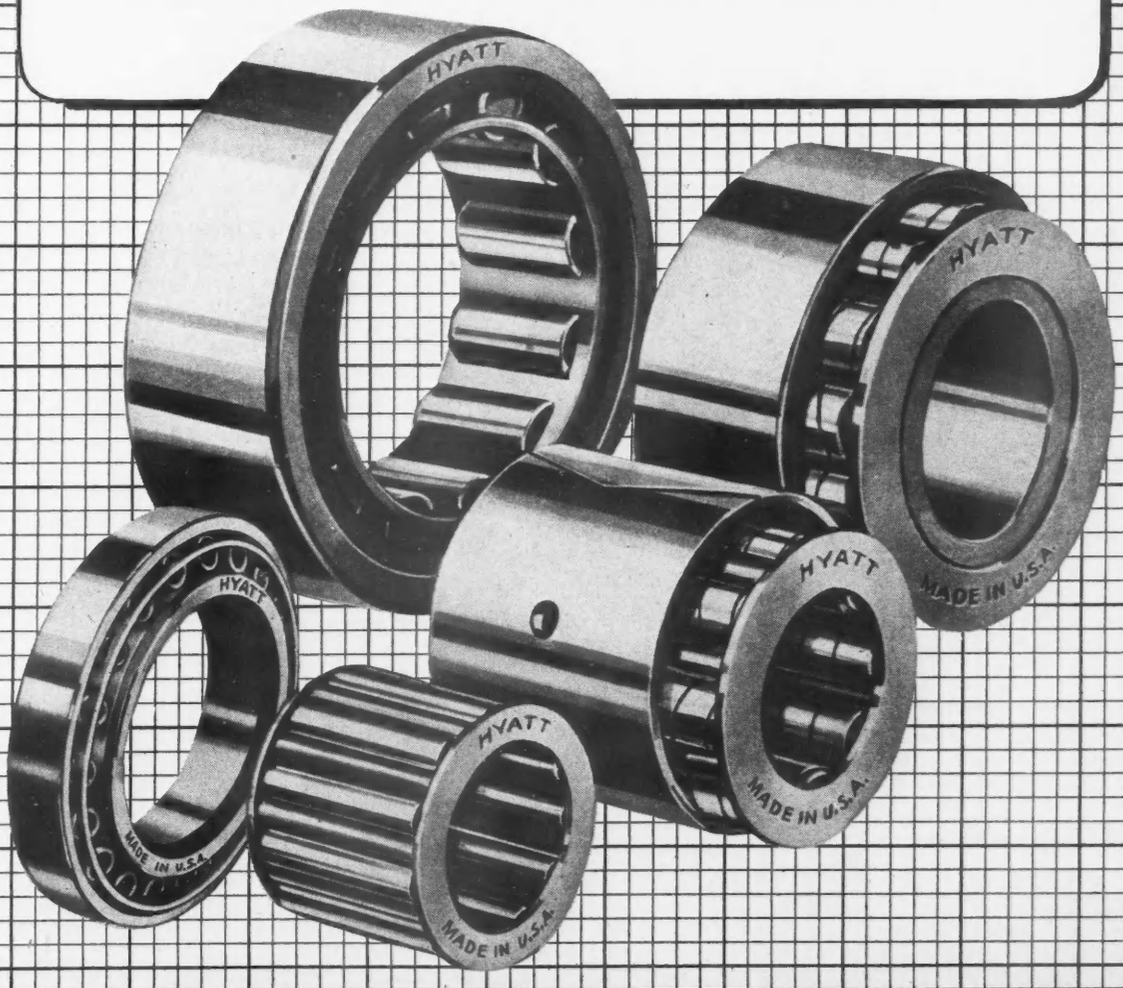
Inside Information

When you buy a machine or a piece of equipment, you want information on what's inside—particularly what grade of bearings you are getting.

When the specifications read "Hyatt Bearings" you know the roller bearings are O.K. in every way.

Leading manufacturers of machines and equipment in various fields—industrial—steel—petroleum—agriculture—textile—construction—transportation—materials handling and other fields, have designed Hyatt Roller Bearings into their equipment to assure smoother operation—longer life and reduced maintenance.

For more than fifty years Hyatt has produced top quality roller bearings to keep things rolling inside, smoother and longer. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



HYATT ROLLER BEARINGS

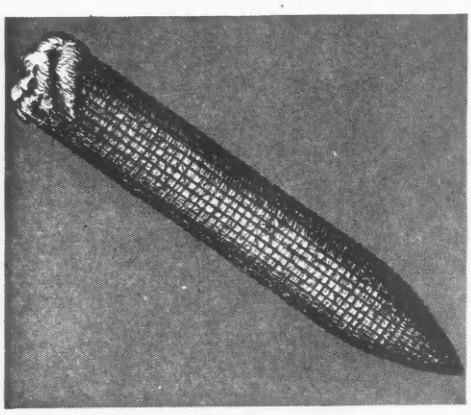
Dorwin Is Elected Chairman Of API Industries Committee

Oscar John Dorwin of The Texas Company has been elected chairman of the American Petroleum Industries Committee of the API, succeeding Edwin S. Hall, who retired last March. Dorwin is general counsel of The Texas Company and has been a member of the APIC since June, 1944.

Dorwin was graduated from the University of Notre Dame in 1917 and received a law degree from Harvard Law School in 1920.

Dorwin practiced law for five years in Chicago before becoming associated with the Indian Refining Company at Lawrenceville, Illinois, as counsel. He later became chief attorney for that company which was acquired by The Texas Company in January, 1931. He continued at Lawrenceville until he was transferred to Chicago as head of The Texas Company's legal office there in February, 1933.

In 1934, Dorwin was transferred to the New York office and was appointed associate general counsel of The Texas Company in 1942. He became general counsel in April, 1944.



Don't risk Bottom Water shutdowns

Eagle-Picher Lead Wool

shuts out Bottom Water!

Prevent costly shutdowns, keep bottom water out of your wells with effective, economical Eagle-Picher Lead Wool. The fine, durable strands fill cracks and crevices with a permanent, non-corrosive seal...save you time and money. Packed in convenient 50-pound sacks — easy to place in special cartridge-shaped Eagle-Picher Wire Containers sized to fit all casings. Order through your jobber today!

These 3 Eagle-Picher Bearing Metals meet most requirements

Dreadnaught — for extreme speed and heavy-duty conditions.

Outlasta — for medium speed and average-load conditions.

Durable—for low speed and light-duty conditions.

EAGLE-PICHER LEAD WOOL

Seals off Bottom Water— keeps 'em flowing!

THE EAGLE-PICHER COMPANY

EAGLE Since EP 1843 PICHER

Cincinnati • East St. Louis
Chicago • Kansas City • Dallas

NACE Plans Short Course September 12-16 in Austin

A "Short Course on Corrosion," sponsored by the National Association of Corrosion Engineers, Houston, is scheduled September 12-16 at the University of Texas, Austin.

Dr. Norman Hackerman of the university faculty is assisting officers of the NACE South Central region in making arrangements for the course, which will serve as a refresher in the fundamental phenomena with which corrosion of metals is concerned.

Kansas AAODC Officers, Committee Chairman Named

Heber Beardmore, Beardmore Drilling Company, Wichita, Kansas, was elected chairman of the Kansas Chapter, American Association of Oilwell Drilling Contractors. C. H. Todd, Rine Drilling Company, Wichita, was chosen vice chairman, and Carl Sebits, Pickrell Drilling Company, Wichita, was named secretary.

Committee chairmen appointed by Breadmore are W. J. Coppinger, Coppinger & Southern, Wichita, programs; Fred Stickle, Stickle Drilling Company, Great Bend, membership; and Bill Burks, Derby Drilling Company, Wichita, publicity.

Board of directors of the chapter consists of three officers and three committee chairmen.

Officers Are Nominated for American Gas Association

Hugh H. Cuthrell, vice president, The Brooklyn Union Gas Company, Brooklyn, has been nominated for president of the American Gas Association. D. A. Hulcy, president, Lone Star Gas Company, Dallas, was nominated for first vice president; George F. Mitchell, president, The Peoples Gas Light & Coke Company, Chicago, for second vice president, and Edward F. Barrett, president, Long Island Lighting Company, for re-election as treasurer. Election of officers will be held at the AGA annual convention in Chicago, October 17-20.

Slated for directors for a two-year term are Edward G. Boyer, Philadelphia; H. R. Cook, Jr., Baltimore; E. H. Eacker, Boston; Joseph N. Greene, Birmingham; Stanley H. Hobson, Rockford; R. H. Lewis, Pittsburgh; Frederick A. Lydecker, Newark; J. F. Merriam, Omaha; Dean H. Mitchell, Hammond; James S. Moulton, San Francisco; J. French Robinson, Cleveland; Paul R. Taylor, New York; Thomas Weir, Ontario; Harry K. Wrench, Minneapolis; C. H. Zachry, Dallas. Charles G. Young, Springfield, has been nominated to fill a vacancy in a term expiring October, 1950.

Mid-Continent Offices Move

Texas Mid-Continent Oil and Gas Association has removed its offices to 1800 M & W Tower, 311 South Akard Street, Dallas 1.

KEEP YOUR CASING STRING WHERE IT BELONGS

...Centered

Ten strong spring staves . . . 3/16" thick x 1½" wide . . . riveted to the rugged end rings of the Larkin Centralizer keep your casing in "bulls-eye" position in the hole. They center your pipe with four times the strength of an ordinary centralizer because there are twice the number of staves and each stave, due to its shorter arc, has twice the centering strength. Larkin's 10 staves work as a unit . . . not individually.

The stagggered stave position provides 10 points of contact, and a much greater peripheral bearing on the wall of the hole. Casing may be rotated while the centralizer remains stationary . . . no damage to tool or well bore. The Larkin Centralizer is always pulled, not pushed, through hole restrictions.

Always specify a Larkin Centralizer " . . . THROUGH YOUR SUPPLY STORE."

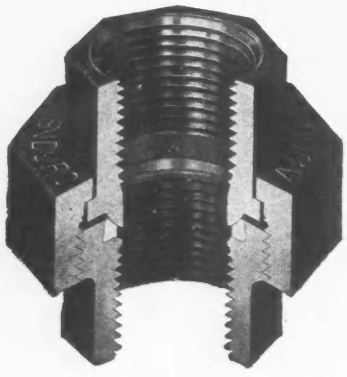
LARKIN

...Through Your Supply Store

Easy to install. Just slip on and plug-weld the lugs inside end rings as shown. "Tailor-made" to hole size. No on-the-job adjustments necessary.

LARKIN PACKER CO., INC. ● ST. LOUIS. MO.

Jefferson Malleable Unions



JEFFERSON'S *ENDURO* unions available in brass-to-iron, and iron-to-iron seats. Certified Air Furnace iron used in the ENDURO line is A.S.T.M.-4733-Grade 35018 malleable, having a 53000# Min. Ten.

ENDURO—300# S.W.P.—600# C.W.P.

Certified Air Furnace iron produces a constant, uniform, finer grain structure union. This provides a much better iron with which to provide a positive dependable seating surface.

Unions manufactured from this malleable iron afford 30% more strength; 50% more impact value; 75% more elongation. Sizes ⅛" thru 3".

Obtainable through your jobber

Jefferson Union Company, Inc.

691 West 26th St.,
New York 1, New York

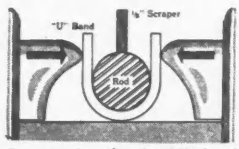
71 Gooding St., Lockport, New York — 31 Fletcher Ave., Lexington 73, Mass.

KEEP YOUR WELLS PUMPING!

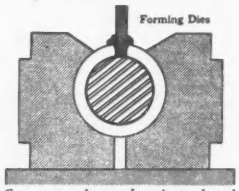
Eliminate Paraffin Accumulation the LOW COST way with...

CRALL SPIRAL SCRAPERED RODS

CRALL Spiral Paraffin Scrapers fit any sucker rod. They are NOT welded to the rod (see illustrations at right), but stay firmly in position to keep tubing free from paraffin. CRALL Spiral Paraffin Scrapers are made to fit 2" and 2½" tubing, and can be attached to your sucker rods at our fabricating plants. The *original* installation is the ONLY cost.



Cross section showing "U" band being die-formed around rod to within a fraction of an inch of scraper blades.



Cross section showing band held under pressure around rod while ends of band are shrink-grip attached to scraper blade.

Order from your Supply Store or Write or Wire Us for full descriptive literature.

PETROLEUM SPECIALTY CO. Manufacturing and Fabricating Plants at Pampa and Levelland, Texas.
P. O. BOX 1640, PAMPA, TEXAS

ASSOCIATIONS

Tompson and Sutter Will Head Equipment Suppliers Group

Guy A. Tompson was elected president of the Petroleum Equipment Suppliers Association at the 14th Annual Meeting at Colorado Springs, Colo.

Guy A. Tompson

T. Sutter was elected vice president of the association. Re-elected were Wharton Weems as treasurer and general Counsel, and H. R. Safford, Jr., as executive secretary.

Total registration for the meeting was approximately 200.

Working Committees Named For AAODC Annual Meeting

With advance registrations promising a new attendance record at the Ninth Annual Meeting of American Association of Oilwell Drilling Contractors, to be held in Dallas September 19-21, Joseph S. Morris, president, announced appointments to important working committees.

Chairmen of the committees are Louis A. Beecherl, McDaniel & Beecherl Drilling Company, General Arrangements; J. E. Brantly, Drilling & Exploration Company, Program; J. L. Rush, Trinity Drilling Company, Housing; W. L. McClusky, M. J. Delaney Company, Registration; F. W. Brigance, Rowan Drilling Company, Finance; C. J. Paine, Paine Drilling Company, Entertainment; Thomas J. Carter, Thomas J. Carter Drilling Company, Banquet; Roy Guffey, Roy Guffey Drilling Company, Publicity; George B. Rice, West Central Drilling Company, Inc., Transportation; and Mrs. W. S. Churchill, Ladies Entertainment.

Gibbons Elected Director Of Rotary International

J. Burr Gibbons, president of Gibbons Advertising Agency, Inc., Tulsa, was elected a director of Rotary International at the International Rotary Convention in New York.

J. Burr Gibbons

Gibbons is one of the founders, former general manager and a 21-year director of the International Petroleum Exposition. He is one of ten elected world directors, only four of whom are from the U. S. Other directors are from Argentina, England, France, Australia, Canada, and Switzerland. Gibbons is former president of the Tulsa Chamber of Commerce.

MARSH

All that we have learned in 80 years of precision instrument making stands before you in the design and construction of every Marsh Gauge and Dial Thermometer.

GAUGES

JAS. P. MARSH CORPORATION • DEPT. K, SKOKIE, ILLINOIS

The Jas. P. Marsh line includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers, and other applications including oxygen and welding gauges.

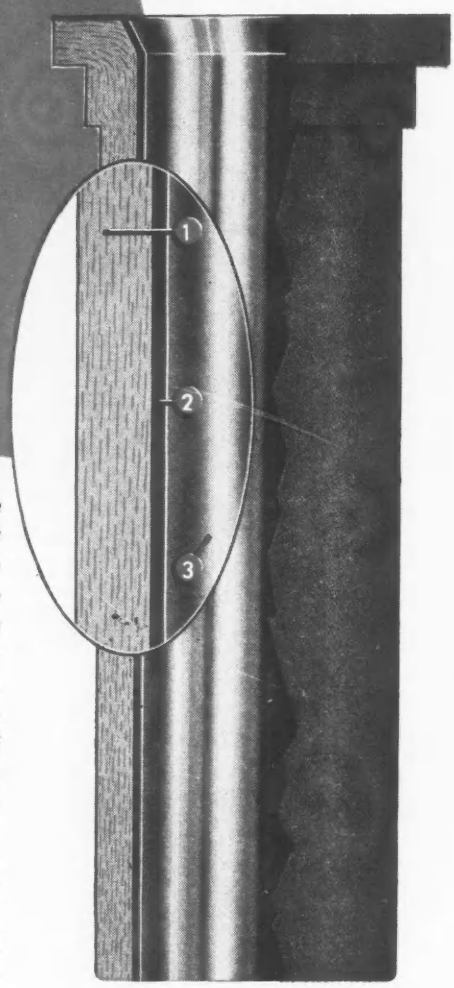
Here's why

FALCON

SLUSH PUMP LINERS

LAST LONGER!

— an achievement in metallurgy



Under the most abrasive mud conditions and highest pressures encountered in drilling, Falcon Liners are turning in record-breaking performances and long service life in the oil fields all over the world. This is no accident. It is the result of combining proper materials with sound engineering know-how.

1 **CHROMIUM - MOLYBDENUM ALLOY STEEL** is made into an integral forging, resulting in a fine, uniform grain structure which increases carburizing effectiveness and greatly facilitates uniformity of hardness. Also makes for a strong, tough core.

2 **EXTREME HARDNESS** 62-65 Rockwell "C" (approximately 700 Brinell) with a depth of penetration of .090" - .120", depending on wall thickness of liner. Careful control of hardness by heat samples and rigid inspection results in minimum distortion. Therefore, no heavy grinding into hardened surface is required to obtain a smooth straight bore, which by the Falcon process, is achieved by honing for both dimension and finish.

3 **SUPER HARD MIRROR FINISH.** A highly polished micro-finish which can only be produced by honing assures longer liner life against abrasion and high pressures.

Sold only through leading supply houses everywhere

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Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

ASSOCIATIONS

East Texas Oil Scouts Elect Stedman President

Lee S. Stedman, The Pure Oil Company, Tyler, Texas, was re-elected president of the East Texas Oil Scouts Association. Wiley W. Wiggins, The Atlantic Refining Company, was named first vice president succeeding Paul Plumer, Magnolia Petroleum Company. N. L. Starr, Shell Oil Company, replaced Ralph Spence, scout for L. A. Grelling, Tyler, as second vice president, and J. Coy Valentine, Phillips Petroleum Company, was elected secretary-treasurer.

Oil Companies Establish Funds for Scholarships

The Socony-Vacuum Oil Company, Inc., will provide $200,000 over the next four years for scholarships and fellowships to be granted by the company's producing department and by two affiliated companies, Magnolia Petroleum Company, Dallas, Texas, and General Petroleum Corporation of Los Angeles.

Under the new scholarship-fellowship program, selected students in various universities will be assisted in completing their courses up to a maximum of $750 per student for each academic year.

California Oil Producers Re-elect Cranson President

L. A. Cranson, executive vice president and director of Honolulu Oil Corporation, San Francisco, was re-elected president of Oil Producers Agency of California.

Cranson has headed the agency, which is composed of independent oil producers operating in California, for the past year. He is also a director of Kettleman North Dome Association.

Other officers elected at the meeting were H. E. Woodworth, Safe Oil Company, Bakersfield, first vice president; R. A. Grant, Fullerton Oil Company, Los Angeles, second vice president; W. H. Geis, petroleum engineer, Los Angeles, third vice president; C. A. Johnson, Holly Oil Company, Los Angeles, fourth vice president.

Rush M. Blodget, who has managed the agency since its organization in April, 1931, was re-elected executive vice president.

W. A. Russell, Seaboard Oil Company, Los Angeles, was re-elected secretary-treasurer and Verne Harrell, Bankline Oil Company, Los Angeles, was re-elected assistant secretary-treasurer.

Constructor Receives Medal

Harold C. Price, president of the H. C. Price Company, Bartlesville, Okla., was awarded the distinguished achievement medal by the Colorado School of Mines for achievement of distinction in the fields of pipe line engineering and construction and business management.

Pipe Liners Plan Dinner

The Pipe Liners Club will hold its annual dinner at the Blackstone Hotel, Chicago, on the evening of November 7, during the API convention.

NATIONAL BANK OF TULSA DIRECTORS

H. G. BARNARD
Investments

A. E. BRADSHAW
President, National Bank of Tulsa

FALKNER C. BROACH
Vice-President, National Bank of Tulsa

W. A. BROWNLEE
Executive Vice-President National Bank of Tulsa

EDWARD H. CHANDLER
Attorney-at-Law

J. A. CHAPMAN
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Vice-President and Secretary, Brown-Dunkin Company

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President
Hanlon Oil Company

J. J. LARKIN
President, Larkin Torpedo Company

P. C. LAUINGER
President, The Petroleum Publishing Company

L. C. RITTS
Investments

A. H. ROGERS
Secretary, J. A. Chapman and H. G. Barnard

DALE R. SNOW
Vice-President
Barnsdall Oil Company

FRANK M. SOWLE
Vice-President, National Bank of Tulsa

CHARLES A. STEELE
Attorney-at-Law

C. H. SWEET
Vice-President, National Bank of Tulsa

STATEMENT OF CONDITION

June 30, 1949

RESOURCES

Cash and Due from Banks	$48,610,569.09	
U. S. Government Securities	68,559,488.59	
Other Bonds and Warrants	3,823,872.27	$120,993,929.95
Loans and Discounts		33,918,870.34
Overdrafts		2,499.58
Income Receivable Accrued		344,811.23
Prepaid Expenses		39,767.12
Stock in Federal Reserve Bank		180,000.00
Bank Premises		2,000,000.00
Customers' Liability Under Acceptances		65,274.00
TOTAL		$157,545,152.22

LIABILITIES

Deposits		$146,108,831.86
Acceptances Executed		65,274.00
Income Collected, Not Earned		132,896.96
Reserve for Taxes, Interest, Etc.		555,185.85
Dividends Declared*		150,000.00
Capital — Common	$3,000,000.00	
Surplus	3,000,000.00	
Undivided Profits and Reserves	4,532,963.55	10,532,963.55
TOTAL		$157,545,152.22

*Payable $75,000.00 July 15, 1949
$75,000.00 October 15, 1949

NATIONAL BANK OF TULSA

The Oil Bank of America

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Perfect Answer For Leak Proof Production Line Connections

RECTORSEAL #1

Ask the man in the field . . . he'll tell you that RECTORSEAL #1 is the answer! It's positive . . . no worries about leaks . . . no galling.
10 years of every kind of test in the field and in the laboratory stand back of your confidence that RECTORSEAL #1 means "no leaks".
Apply easily with brush or swab to each joint of pipe and you'll see for yourself RECTORSEAL is LEAK-PROOF!

Ask your supply store for RECTORSEAL #1 by name.

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2215 Commerce St. Houston 2, Texas
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Manufactured by
RECTOR WELL EQUIPMENT CO., INC.
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MAKING THE OIL INDUSTRY SAFER

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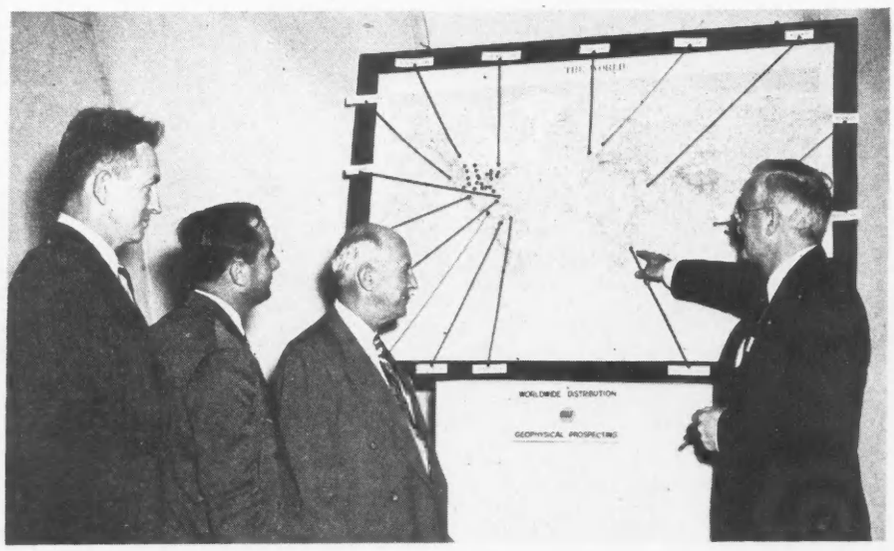
You can maintain your required speed for the full period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

W·H·CURTIN & CO.
HOUSTON . . . . NEW ORLEANS

Men in the Industry NEWS



PRODUCTION ENGINEERS CONFER—A map locating Gulf Oil Corporation's world wide prospecting operations is inspected by delegates to the company's fifth production engineering conference it Pittsburgh. Left to right are B. M. Moroney, mechanical engineer, Tulsa division; R. E. Storms, chief petroleum engineer, Mene Grande Oil Company, C. A., Maracaibo, Venezuela; J. C. Phillips, assistant superintendent of production, Shreveport; and R. D. Wyckoff, director, geophysical research and development division, Gulf Research & Development Company. More than 180 engineers, technical specialists and officials representing Gulf operations in the U. S., Canada, South America, Europe and the Middle East attended the conference. Delegates heard 35 papers dealing with latest developments in drilling and oil production techniques, well logging methods, corrosion, and reservoir operations.

Florent H. Bailly, recently elected to the presidency of Pantepec Oil Company, C. A., and Pancoastal Oil Company, C. A., of Venezuela, has been with Pantepec Oil Company since the beginning of 1928. He has been active in the engineering and geologic departments of the company, and since 1938 has acted as chief engineer and chief geologist.

Florent H. Bailly

Bailly is a graduate of the California Institute of Technology, 1927, and worked from that time until 1942 in Venezuela. Since 1942 he has resided in the U. S. but continued his activities in Venezuela.

Bailly is also president of Petroleum Engineering Associates, Inc., and Oil Properties Consultants, Inc., of Pasadena, Calif., petroleum engineering and laboratory firms, which he was instrumental in forming in 1947 and 1948.

»

W. Ed Leroux has resigned as drilling superintendent for The Carter Oil Company to become production manager for C. L. McMahon, Inc., of Tulsa. **Sam Wells,** geologist, has also joined McMahon as manager of exploration. He formerly was associated with Ashland Oil and Refining Company.

»

Charles Roy Auster, assistant purchasing agent in charge of domestic assignments, has retired from Socony-Vacuum Oil Company, Inc., after 45 years. **Earl W. Beck,** who has been assistant purchasing agent in charge of foreign assignments, has been made assistant in charge of both domestic and foreign purchasing. Beck formerly was manager of purchases of General Petroleum Corporation, Los Angeles, a Socony-Vacuum affiliate. He was transferred to Socony-Vacuum in 1946.

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Custom built...
MUD PITS
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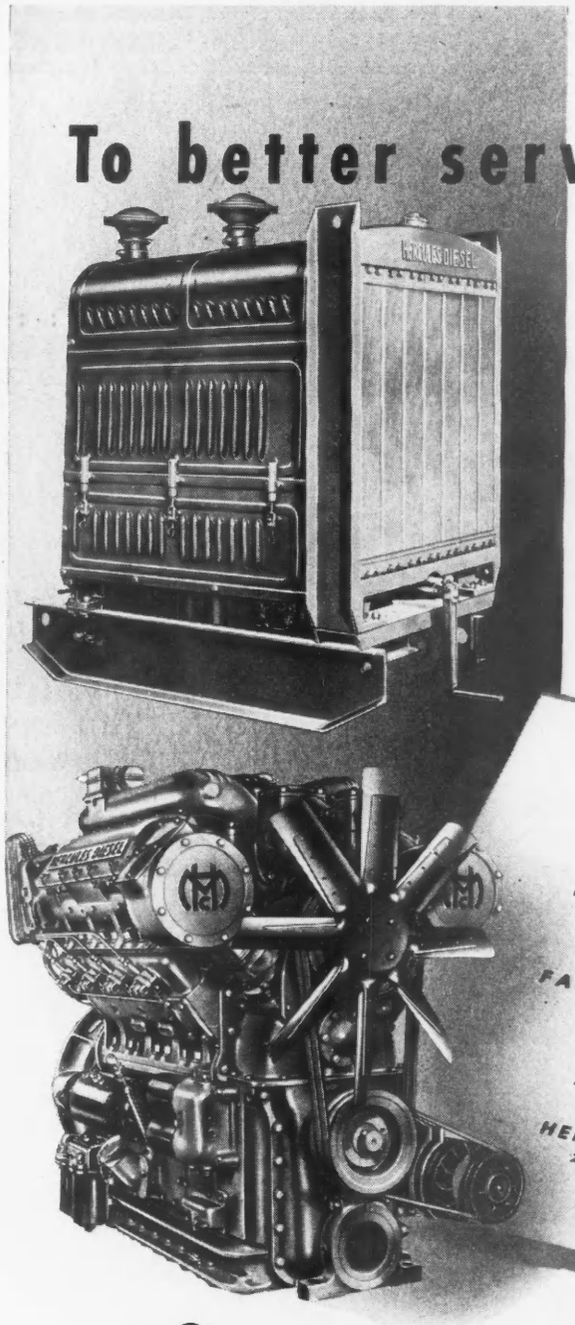
DEPENDABLE

HERCULES

POWER UNITS - ENGINES AND PARTS



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CANTON 2, OHIO, U. S. A.
Announces the opening of a
FACTORY SALES AND SERVICE BRANCH
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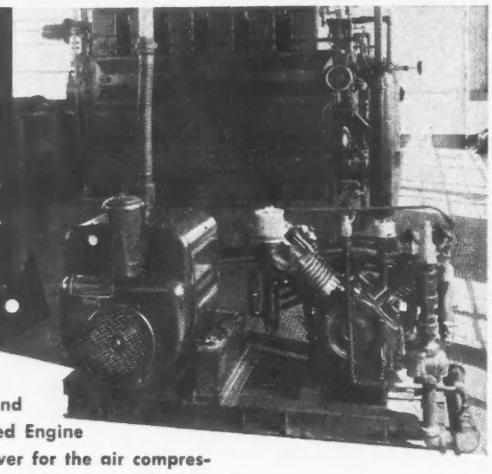
HERCULES MOTORS CORPORATION • CANTON 9, OHIO, U. S. A.

Power at the Push of a Button..

WITH THIS
WISCONSIN
HEAVY-DUTY
Air-Cooled
ENGINE.....



Push the starter button just once . . . and this Wisconsin Heavy-Duty Air-Cooled Engine springs to life, providing effortless power for the air compressor that supplies starting air for the big diesel in the background!

Leading equipment builders and the users of their machines know that *all* Wisconsin Engines deliver heavy-duty dependability and service in the 2 to 30 hp. air-cooled range . . . from oil pumps to shot hole drilling rigs . . . through midwinter rain and sleet, and under the hot summer sun as well. Tough going doesn't faze such Wisconsin features as tapered roller bearings at *both ends* of the crankshaft . . . air-cooling in temperatures from sub-zero to 140°F . . . quick starting and steady running in any weather.

4-cycle, single, two-, and four-cylinder models, 2 to 30 hp.

WISCONSIN MOTOR
Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

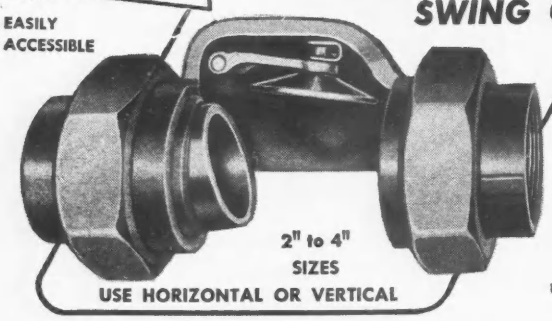
WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

if it's a CATAWISSA . . . it's DEPENDABLE!

NEW! now . . . FULL OPENING for unobstructed flow!

COMPACT
EFFICIENT
EASILY ACCESSIBLE

CATAWISSA DOUBLE UNION SWING CHECK VALVES



2" to 4" SIZES
USE HORIZONTAL OR VERTICAL

FLOW LINE AND PIPE LINE TYPE for general use

designed for use in lines where no stop is installed close to the check valve and where pipe cleaning mechanisms (go-devils) are used!

Here it is . . . Catawissa's newly improved, full opening valve with union connections on both ends to permit breaking the line at inlet end with check holding contents of the line!

Recommended for 250-lbs. Working Steam pressure 500-lbs. Oil, Water, Gas Tested 1000-lbs. NSHP

DISTRIBUTED BY
OIL WELL SUPPLY COMPANY
BRANCHES SERVING ALL OIL FIELDS
WRITE FOR BULLETIN 10-A
CATAWISSA VALVE & FITTINGS COMPANY CATAWISSA, PENNA.

MEN IN THE INDUSTRY NEWS

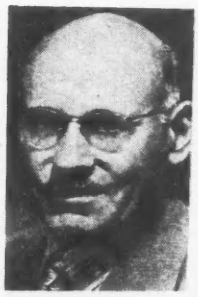
Ralph K. Paine

C. C. Gester

G. C. Gester, chief consulting geologist for Standard Oil Company of California, has retired. He had been with the company since 1917, first as senior geologist, later as chief geologist. Gester has written numerous published papers on petroleum geology and petroleum engineering. He is a member of the AIME, the California Academy of Science, a past president of the AAPG, and a member of API.

Ralph K. Paine has been appointed manager of Standard of California's

Clyde A. Swigart



Roy E. Darke

pipe line department, to succeed **Clyde A. Swigart,** who has been elected a vice president of the Trans-Arabian Pipe Line Compnay. Paine has been general superintendent of the southern California district of the pipe line department since 1946. He is succeeded in that position by **L. E. Joses. E. B. Saunders** will be superintendent of the southern district. **E. J. Hyde** has been made superintendent of operations control for the department.

Roy E. Darke, geologist with the company for the past 30 years, has retired. Darke served in South America for eight years, and for the past 15 years has been engaged in geological work in the San Joaquin Valley, with offices at Bakersfield.

Charles L. Brewster, Northern district drilling superintendent, has retired after 40 years service with the company. He is succeeded by **F. A. Heitmeyer,** who will headquarter at Taft, Calif. Brewster is a senior member of Petroleum Production Pioneers. Heitmeyer has been with Standard of California 25 years, since his graduation from the University of California in 1924.

J. G. Stevens, formerly vice president and treasurer of Douglas Oil Company, of California, Los Angeles, has been elected executive vice president and treasurer. **D. L. Commons,** formerly assistant secretary, was named secretary; **G. E. Clarke,** assistant secretary, and **Earl S. Sharp,** assistant to the president.

Questions & Answers

about the many unique features in the Shaffer Combination Rotating Blowout Preventer and Stripper

BECAUSE IT is so complete, so adaptable, so trouble-free in all types of pressure control operations, operators everywhere are asking for more information about the Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper. Typical questions include . . .

"DOES IT REQUIRE SPECIAL STRINGS OF PIPE? *We like to simplify our operations and inventories as much as possible and are wondering if your unit requires flush joint or other special pipe."*

NO! The Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper requires no special drill string equipment of any kind. It packs off around *any* type of pipe—coupled, upset or flush—with equal efficiency and safety. What's more, it maintains its leak-proof seal *continuously* while any type of pipe is raised or lowered through the unit!

"WHAT OPERATIONS ARE NEEDED TO PACK OFF THE UNIT? *Pressure emergencies happen fast. What operations are required to seal-off against pressure leakage around the drill string?"*

NONE! The Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper is *always* packed off while the drill string is in the hole. No matter how sudden the pressure emergency, it can't be too fast for the Shaffer Preventer *because no operations whatever are needed to place it in operation!*

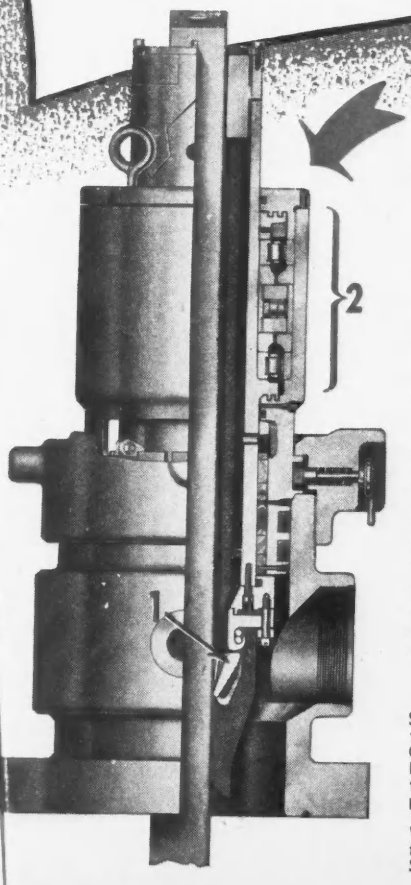
"CAN BITS AND REAMERS BE PASSED THROUGH THE UNIT *with maximum ease, safety and simplicity?"*

DEFINITELY YES! Just pull a latch, rotate the Bonnet 1/6th turn and the entire internal mechanism rides out on top of the bit or reamer. Simply reverse the operation when going back into the hole. It's as easy as that—*and as quick!*

"HOW ABOUT THE KELLY? *Is a special kelly needed to keep from damaging the sealing rubber?"*

NO SPECIAL KELLY IS NEEDED with the Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper. You can use a square, hexagon or octagon kelly—whichever you prefer—and the *same* unit seals as effectively around each type. What's more, because the Stripper Rubber rotates *with* the kelly—not around it—there is virtually no wear on the Rubber while drilling. Cuts maintenance, assures better pack-off and a maximum of trouble-free safety!

. . . and note these features



There are many other unique advancements incorporated into the Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper of which the following are typical . . .

1. EXPANDABLE STEEL BARRIER PROTECTS RUBBER. Note how the Stripper Rubber is protected by a barrier of steel latches that expands and contracts to permit normal flexure—but safeguards against extrusion or abnormal expansion.

2. ADVANCED BEARING DESIGN. Thrust and radial loads are carried on separate bearing assemblies, each specifically engineered for its particular type of service. In addition, the radial bearings are widely-spaced to provide ample resistance against wobble and gyrating loads.

These and still other unique advancements make the Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper the most *efficient*, most *versatile*, most *positive* pressure control unit yet developed. Get *all* the details on this years-ahead control unit from your Shaffer representative. Or write

See pages 3843 to 3894 of your Composite Catalog for information on the complete Shaffer line.

Write for your free copy of the Shaffer Catalog.

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
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OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
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Robert L. Boggs was elected a director of the Mene Grande Oil Company, C.A., and named a vice president.

Boggs was graduated from the University of Kansas in 1927 with a bachelor of science degree in mining engineering, petroleum option. He joined the Tulsa division of Gulf Oil Corporation as district engineer in June, 1927, and in 1928 he transferred to the Venezuela Gulf Oil Company in western Venezuela, where he successively served as production engineer, chief petroleum engineer and executive assistant until assigned to Caracas as assistant to the president of Mene Grande Oil Company in January, 1939. He remained in Caracas until August, 1946, when he moved to San Tome as general superintendent and assistant division manager. He was appointed division manager of Mene Grande's eastern Venezuela operations in March, 1947.

Luis Herrera, executive assistant of Mene Grande since 1946, has been appointed assistant to the president. Herrera was in government service before he joined Mene Grande, and served as petroleum inspector general of Venezuela for many years. In 1943 he was made director of the Venezuelan Technical Office of Hydrocarbons, a position he held until 1946.

A graduate with a degree in civil engineering from the Central University of Venezuela, Herrera was conferred the degree of chemical engineer by the University of Texas in 1938.

Luis Herrera

Robert L. Boggs

Edward A. Skinner

F. C. Sealey

F. C. Sealey has been elected a vice president of The Bahrein Petroleum Company Limited, in charge of producing and exploration, with offices in New York. **Edward A. Skinner** has been elected vice president in charge of government and public relations in the Persian Gulf, with offices in Manama, Bahrein.

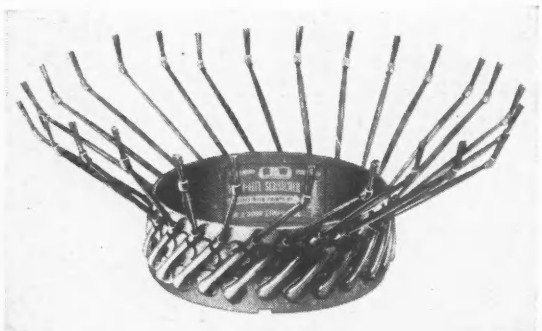
Sealey is also executive vice president of American Overseas Petroleum Company. He entered the oil industry 32 years ago as an assistant geologist, and for the past 11 years has been associated with foreign producing activities. He was graduated from Colorado School of Mines in 1917, with the degree of Engineer of Mines, and took special work in petroleum geology.

Skinner was formerly vice president of Trans-Arabian Pipe Line Company.

Roy C. Busby, secretary of the Whitehill Oil Corporation, Tulsa, has been elected vice president and treasurer of the company. **George L. Hangs** was elected secretary and assistant treasurer.

Harry L. Arnold, former assistant state attorney general for Illinois, has been appointed assistant to **O. C. Schorp,** president of The Carter Oil Company. He is a graduate of Northwestern University and the Harvard law school.

A. T. Gibbon has joined The Carter Oil Company's geological staff and has been assigned to Mattoon, Ill., in the Eastern division.



B and W Multiflex Scratcher

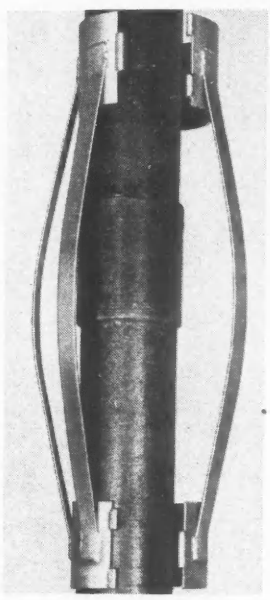
Remove Mud Cake, Center the Casing and You'll

CUT CEMENTING FAILURES to the Core!

MORE AND MORE OPERATORS are getting better cement jobs the first time, eliminating need for squeeze cementing and saving thousands of cementing dollars with this B and W equipment. Here's how:

MUD CAKE REMOVAL is accomplished with B and W Multi-Flex Scratchers installed on the casing opposite the cementing zone. Strong multiple-wire fingers 5" long combine strength with reversibility . . . are flexible to adapt themselves to hole contour for minimum disturbance of the mud cake while running in . . . insure *complete mud removal* during cementing operations.

CASING CENTERING with B and W Latch-On Centralizers installed either at the rack or rotary table eliminates troublesome channeling, insures better cement bond between casing and formation. Split hinge construction makes installation easy on either collared or external upset casing . . . both straight and spiral types are available to meet all well conditions.



B and W Latch-On Centralizer

If cementing failures are robbing you of profits, plan *now* to use economical B and W equipment on well completions. We'll be glad to send you full details—write us today!

Don't Squeeze! **. . . it CAN be avoided**

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● Why? Because Republic Electric Weld Casing and Tubing are uniform throughout every length and every shipment . . . uniform in diameter and roundness . . . with uniformly clean, accurate threads that take hold and spin up tight in a hurry.

These *modern* tubular products provide valuable underground protection, too. Uniform wall thickness . . . adequate metal under the threads . . . and sound, scale-free inside surface all combine to offer high resistance to pull-out and collapse.

Republic Electric Weld Casing and Tubing are formed only from high ductility steel. Every length is fully normalized for uniform structure. Casing is cold sized for high yield strength—additional assurance of full dependability on every job.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • • • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

Republic Electric Weld Casing and Tubing are made from flat-rolled steel, both sides of which are inspected. Thus, the surface which becomes the inside wall is free from hidden defects.

REPUBLIC *Electric Weld*
NORMALIZED CASING AND TUBING

REPUBLIC STEEL
REG. U.S. PAT. OFF.

Other Republic Products include Line Pipe—Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

R. F. Baker, general manager of the Domestic Producing department of The Texas Company, with headquarters at New York, was elected a vice president in charge of Domestic Producing operations. Baker has spent 33 years in the Crude Oil Producing department of the company. He succeeds **R. Ogarrio.**

Ogarrio, who was vice president in charge of Domestic Producing, was made chairman of an Executive Producing Committee which will consider crude oil production policy on a worldwide basis. He remains a director and a vice president of the company.

L. H. Lindeman, treasurer, was elected a vice president in charge of financial matters. He has been with the company since 1910 in the Treasury department.

»

Robert Fisher, assistant treasurer, was elected treasurer to succeed Lindeman. He has been with the company since 1910 and has been assistant treasurer for the past ten years.

»

A. C. Long, assistant to the chairman of the board, was elected a vice president in charge of all foreign operations in the Eastern Hemisphere. Long's service of nearly 20 years with the company has been principally in foreign work.

»

W. R. Young has been appointed manager of the Federal Taxation division of the Legal department of The Texas Company. Young succeeds **G. R. Page,** who has retired after nearly 32 years of service with Texaco.

»

W. H. Loomis, The Texas Company, has been appointed superintendent, Ventura district, at Santa Paula, Calif. **R. L. Jackson** has been named superintendent, Los Angeles Basin district, at Signal Hill, Calif.

»

T. R. Beauchamp was made assistant superintendent of Los Angeles Basin for production, gasoline and drilling operations, supervising gas and gasoline operations in the area.

»

J. H. Sembower has been appointed assistant to the executive vice president of Shell Oil Company and will have direct responsibilities for Shell public relations activities on the Pacific Coast. Sembower assumes his new position after a year's special assignment as director of the International Road Federation.

J. H. Sembower

Sembower joined Shell as a salesman in 1938. He subsequently served in the Personnel department and in 1941 was appointed manager of the Public Relations department in New York, the position he held until leaving for service with the Navy in 1942. On his return in 1946, he became head of personnel, industrial relations, and training for Shell's Texas-Gulf Coast area, with headquarters in Houston. **Sterling A. Germany,** formerly district land agent, has been made chief land agent for Shell Oil Company's Houston area. He replaces **Hugh Dickerson,** who has been transferred to the Tulsa office. **Earl M. George,** formerly senior landman at the San Antonio office, succeeds Germany as district land agent.

Germany has been with Shell for 23 years, beginning as a draftsman in the Dallas office. In 1934 he was transferred to the scouting section at Tyler, Texas, and in 1939 was made landman in the Tyler land department. He was appointed district land agent in Houston in June, 1947.

George joined the company in February, 1942, as a land utility man in Centralia, Ill. He served in Saginaw, Mich., before being transferred to San Antonio.

»

Ken R. Burns, petroleum geologist, Tulsa, has opened consulting offices in the Panhandle Building, Wichita Falls, Texas.

»

W. E. McCommons, formerly with Halliburton Oil Well Cementing Company, has joined the Geological department of Coy Oil Company at Evansville, Ind.

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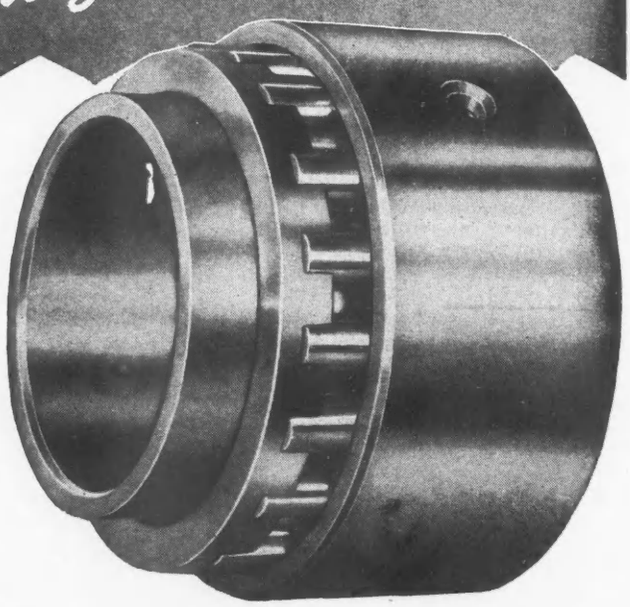

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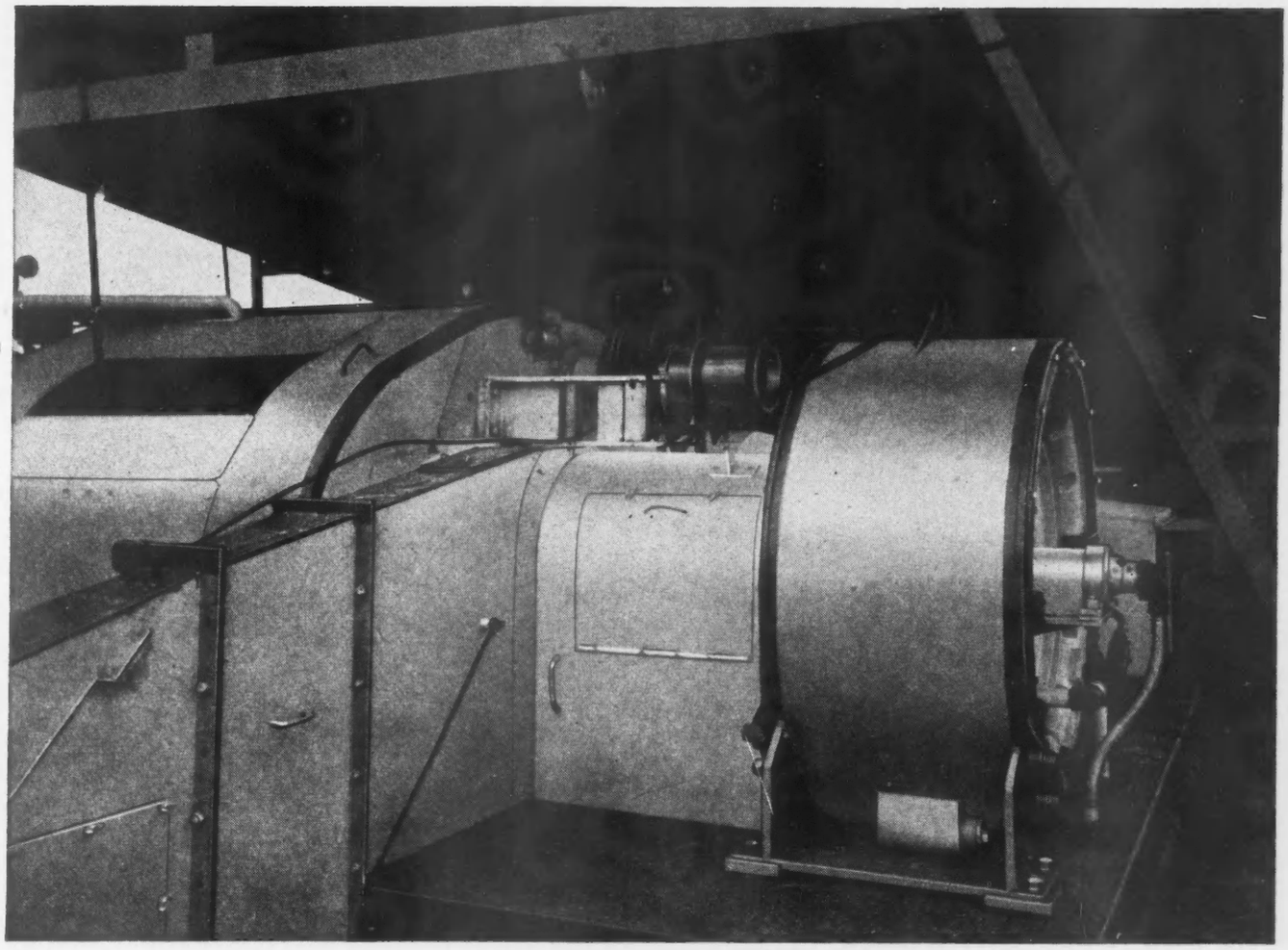

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Ralph E. Clarke, treasurer of Standard Oil Company (Indiana), retired after more than 42 years with the company. **Walter A. Culin,** assistant treasurer, succeeds Clarke.

Clarke joined Standard of Indiana in 1906 as a stenographer in the general office at Chicago. After becoming assistant auditor and auditor of the Manufacturing department in 1919, he was made general auditor in 1921. In 1924 he was appointed assistant secretary and assistant treasurer, positions he held until 1939 when he was promoted to treasurer.

Culin joined the company in 1945 as assistant treasurer after serving as a vice president, treasurer and director of Federal Water and Gas Corporation of New York City.

»

John A. Poulkin of Kingston, N. Y., has been appointed head of the foreign branch of the Oil and Gas division, Department of the Interior. He has had foreign service with Sinclair Exploration Company, The Texas Company and Superior Oil Company.

George W. Evans

Millard K. Neptune

Millard K. Neptune has been appointed manager of Continental Oil Company's new Foreign department.

S. V. McCollum

A graduate of the law and engineering schools of the University of Oklahoma, Neptune started working for Phillips Petroleum Company in 1933. During World War II, he was with PAW and later spent three years in Venezuela as assistant manager of Phillips Venezuelan Oil Company. He joined Continental last year. Headquarters of the Foreign department will be in New York City.

George W. Evans, formerly general purchasing agent for Continental, has been appointed to the new position of coordinator of pipe lines and manager of purchasing. **S. V. McCollum,** who was assistant purchasing agent, succeeds Evans as purchasing agent.

Porter M. Powell has been appointed director of the new Organization and Procedure division of Continental's Industrial Relations department at Ponca City, Okla.

»

Halbert M. McClain has resigned from the Petroleum Engineering department of Magnolia Petroleum Company to become an engineering consultant in Dallas, specializing in petroleum and chemical engineering.

»

C. M. Hinton has been named manager of production and drilling for American Republics Corporation, Houston. Hinton was formerly stationed at Calgary, Alberta, Canada, as assistant manager of the Texaco Exploration Company in charge of drilling and production. Prior to his service in Canada, Hinton was with The Texas Company's Operating department in South Texas for 11 years.

Robert M. Beatty was appointed manager of the Geological division. Beatty was formerly with DeGolyer and MacNaughton at Dallas and with Trinity Petroleum at Houston.

J. P. Black has been appointed manager of the Geophysical division and coordinator of exploration activities. He was formerly manager of the Geological and Lease division.

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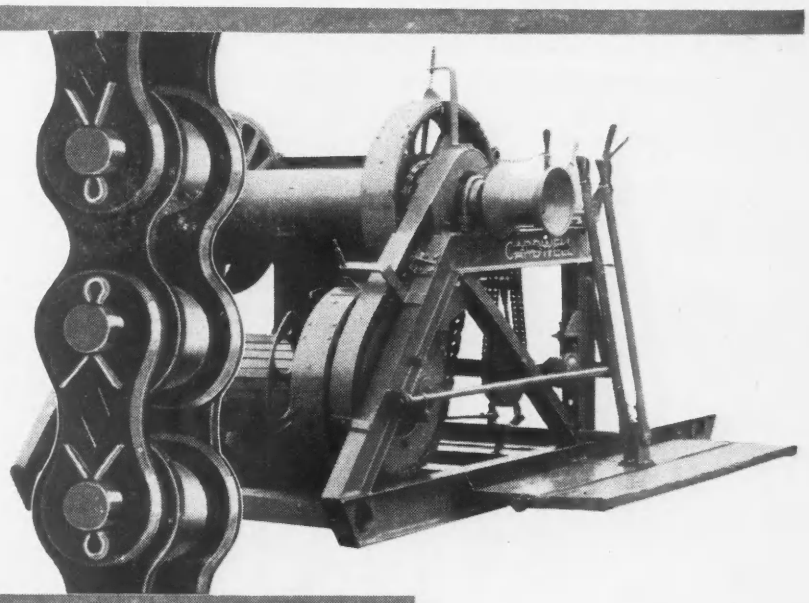

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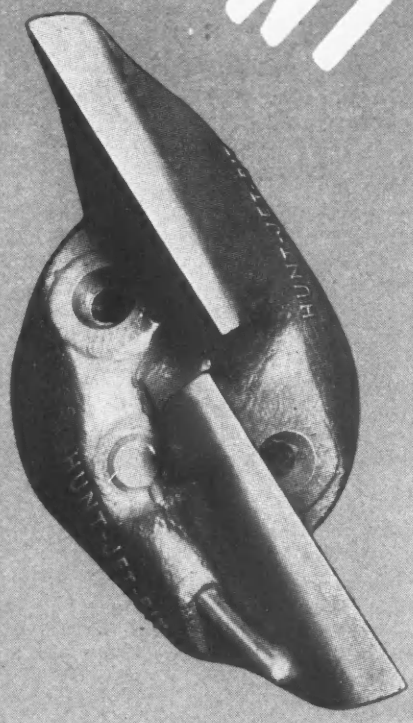

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Transfers and Promotions:

Hugh Dickson, formerly chief land agent for Shell Oil Company, Inc., has been transferred to Tulsa, where he will be chief land agent for the Tulsa area. **C. W. Michaels,** scout in the Kansas division, has been promoted to chief scout and transferred from Wichita, Kansas, to area headquarters at Tulsa. . . . **Ernest G. Robinson,** vice president and area manager of Shell Oil Company of Canada, Ltd., had experience with Shell organizations in Illinois, Texas and Louisiana before going to Calgary from New Orleans. Also from New Orleans is **W. G. Gaines,** office manager in charge of office routine in the headquarters in the Maerov Building, 536 Eighth Avenue West, Calgary. **W. S. Henry** was transferred from Tulsa as land manager.

H. M. Fritts, who left Calgary to become exploration manager at Midland, Texas, has been succeeded by **M. S. Metz,** who went from Midland to become exploration manager and chief geologist. Other members of his staff include H. L. Koch, area geologist, from New Orleans; **W. H. Allen** and **R. S. Mann,** from Midland and Corpus Christi, Texas, respectively, who are district geologists. **T. Rozsa,** formerly district geophysicist at Baton Rouge, La., has become chief geophysicist at Calgary. **J. R. McGehee,** who will serve as chief stratigraphist, is on loan from Shell Oil Company, Inc., at Tulsa.

Phillip D. Manning, Jr., has been named division engineer for Stanolind Oil and Gas Company at Oklahoma City, succeeding **M. P. Huntington,** transferred to the company's Economics department at the office in Tulsa. **Weldon C. Julander,** geologist, has been transferred from Albuquerque to Wichita. **D. B. Mason, Jr.,** has been named district landman for Stanolind at Jackson, Miss., succeeding **J. Troy Stalls,** transferred to Casper, Wyo., as assistant division landman for the Rocky Mountain division. In the Texas-Louisiana Gulf Coast division, **Robert O. Williams,** Houston, has been transferred to Corpus Christi, Texas, as district engineer. **Charles D. Browder, Jr.,** petroleum engineer, moved to the Houston division office from Alvin, Texas; **H. H. Steele,** field engineer, to South Houston from Liberty, Texas; **W. T. Moore** from Turtle Bay to High Island, Texas, as production foreman; **J. C. Jackson,** Oklahoma City, to Harlingen, Texas, as gravity meter party chief; **G. E. Taylor,** magnetometer operator in charge of a party at Uvalde, Texas. The area office at Turtle Bay has been closed and the field operations assigned to area offices at High Island, Alvin and Beaumont. In the North Texas-New Mexico division, **Fred L. Nabors,** petroleum engineer, was transferred to the Fort Worth division office from the district office at Lubbock, and **George W. Tracy,** petroleum engineer, moved to the district office at Midland from the general office at Tulsa. **R. M. Reeves,** marine terminal superintendent at Stanolind's Galveston offshore operations base, has been named production foreman at Lafayette, La. He is succeeded by **William A. Kimbrough,** formerly petroleum engineer in the Gulf Coast division. . . .

W. G. Iverson has been named district scout for Kansas for Continental Oil Company, succeeding **Roger Messman,** transferred to the Geological department at Ponca City, Okla., headquarters. . . . **William B. Strickler,** land and exploration manager in Michigan for Sohio Petroleum Corporation, has been transferred to Canada and will headquarter in Calgary, Alberta. . . . **Graydon H. Laughbaum,** formerly district geologist, has been named research geologist for the Central division, Sinclair Oil and Gas Company, with headquarters at Oklahoma City. . . . **G. C. Boyles,** Shell Pipe Line Corporation, transferred to Vinita, Okla., where he is supervising electrical and maintenance work on the Ozark Pipe Line system between Cushing, Okla., and Diamond, Mo. . . .

Ralph Cadenhead, former scout for Magnolia Petroleum Company at Ardmore, Okla., has been transferred to Oklahoma City as assistant district landman. **Fred Dulaney,** formerly scout at Wichita, has moved to Oklahoma City as assistant district landman. **John F. Conley** has been made general super-

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intendent of part interest operations with headquarters in Dallas. He was formerly division superintendent of the Kansas division. **W. B. Powers,** assistant division superintendent of Magnolia's Gulf Coast division, was promoted to division superintendent of the Kansas division at Wichita. **J. J. Bresenham,** Jr., assistant district superintendent at Kermit, Texas, was transferred to Pampa, Texas, as district petroleum engineer. **E. G. Blundell,** production foreman at Kermit, was made assistant district superintendent in the Kermit Producing district.

V. L. Red, superintendent of Magnolia Pipe Line Company's West Texas district, Midland, transferred to Olden as district superintendent. **C. C. Coffindaffer,** Olden district superintendent, was transferred to Healdton, Okla., as district superintendent of the Healdton district. **H. M. Van Buskirk,** district superintendent at Healdton, moved to Midland as district superintendent of the West Texas district.

»

William J. Wilkins, chief engineer for the Tulsa Pipe Line division, Gulf Oil Corporation, has been transferred to Pittsburgh. . . . **Dr. A. B. Bryan,** chief geophysicist for The Carter Oil Company, Tulsa, has been transferred to the Production Research department of Standard Oil Development Company, New York. He will work on the coordination of research activities in oil finding and production. . . .

»

C. G. Gearhart, Jr., and **W. L.** Kennedy have been promoted from hydraulic engineer to senior engineer and from engineer to hydraulic engineer, respectively, by Stanolind Pipe Line Company. Gearhart succeeds **H. L. Drake,** head of the company's new Purchasing department.

»

R. D. Rhinehart, assistant area production superintendent at Crane, Texas, for Gulf Oil Corporation, has been transferred to the Wickett, Texas, area.

»

R. E. Bridges has been appointed superintendent of Humble Oil & Refining Company's Gulf Coast division. The former assistant division superintendent replaced **C. W. DeLancey,** who retired after more than 30 years with Humble.

»

R. K. Tracy, former superintendent of the Galveston Bay district, was

R. K. Tracy

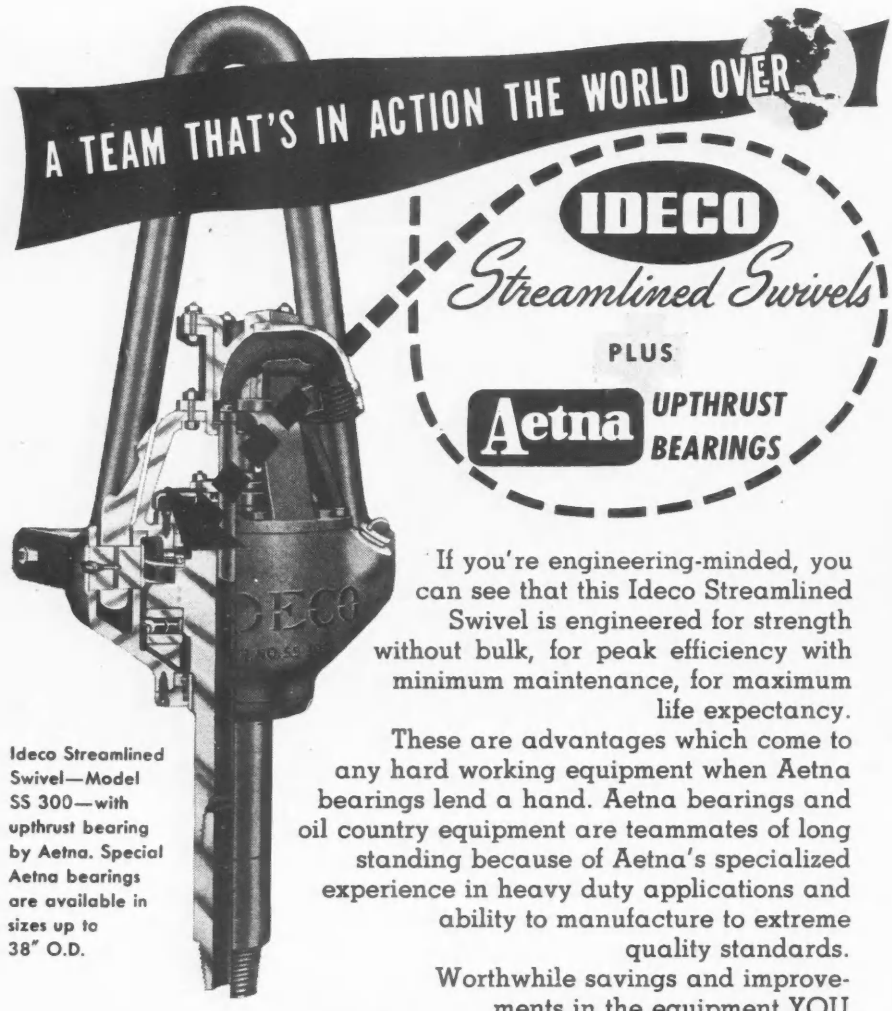
R. E. Bridges

named to succeed Bridges as assistant division superintendent. Tracy was replaced at Galveston Bay by **D. C. Rhodes,** former superintendent of the Lovell Lake district, and Joel C. Ott was transferred to Lovell Lake from Eucutta district in the Louisiana division.

DeLancey, retiring division superintendent, was honored by 175 friends and associates with a retirement party in Houston recently. DeLancey developed directional drilling techniques for controlling wild wells, and on several occasions acted as advisor on oil operations in foreign countries.

Bridges joined Humble in 1923 and worked in the Civil Engineering department until 1936, principally in North Texas. In 1936 he moved to the Gulf Coast division to take over duties in petroleum engineering, and was made assistant division superintendent in August, 1946.

Tracy joined Humble in West Texas as a roughneck in 1928. During succeeding years he was a junior engineer in the old Corsicana division, a member of the Gas division in Houston, district petroleum engineer at Thompsons, assistant division petroleum engineer, farm boss in several districts, and tool pusher. In 1939 he became district superintendent at Magnet, moving to Lovell Lake in 1941 and to Galveston Bay in 1948.



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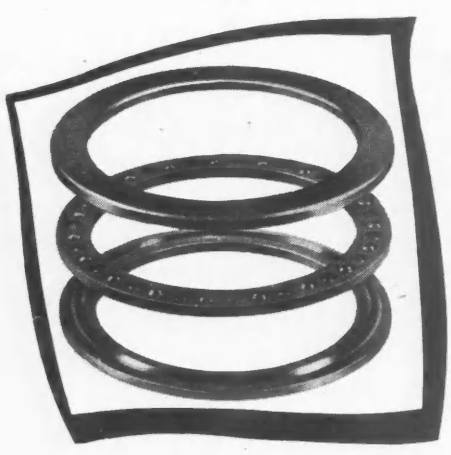

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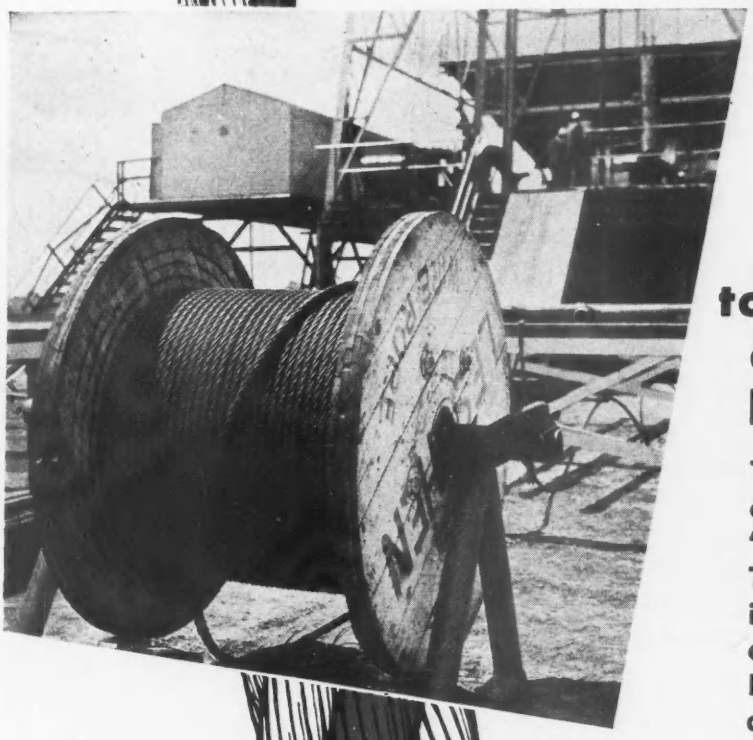

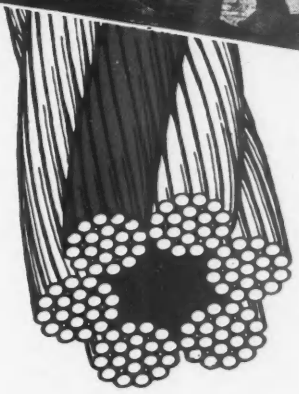

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DEATHS

Hebert Sidney Austin, 65, pipe line designer and engineer, died in Easton, Md., July 5. He had retired as coordinator of the pipe line systems of the Standard Oil Company (N.J.) in 1940 after 25 years service with the company, and opened his own office as a consulting engineer in New York.

Herbert S. Austin

In World War II Austin served as consulting engineer to the U. S. Navy in its Iceland installations and to the U. S. Army in its Iranian pipe line project. After the war he served as field superintendent for M. W. Kellogg Company at Aruba.

Austin is best known for his designing and building of the 600-mile, 12-inch pipe line system of the Iraq Petroleum Company, from the Kirkuk fields to Haifa, Palestine, and Tripoli, Lebanon. This was the first major all-welded pipe line ever built outside the U. S. He also supervised construction of other pipe lines in the Middle East and at the time of his death was consulting engineer for IPC on its new 16-inch system now under way paralleling the existing lines.

Beauford H. Jester, 56, governor of Texas, died July 10 in Houston. Prior to his election as governor, Jester had served as a member of the Texas Railroad Commission.

Beauford H. Jester

A graduate of the University of Texas and the Harvard University Law School, Jester practiced law in Corsicana, Texas. His career was closely connected with the oil industry during the boom years in the Corsicana fields.

Jester was appointed to the board of regents of the University of Texas in 1929, and later became chairman of the board.

»

L. H. Prichard, 68, chairman of the board of Anderson-Prichard Oil Corporation, Oklahoma City, died June 19 at Oklahoma City. He entered the oil business in 1915, and helped found Anderson-Prichard Oil Corporation in 1922. He served as president of the corporation until 1947, when he was made chairman of the board of directors.

»

Charles F. Roeser, 61, Texas independent oil operator, died July 14 in Fort Worth. Roeser was president of Roeser and Pendleton, Inc., and was chairman of the board of the Continental National Bank of Fort Worth. Roeser's work in behalf of independent oil operators resulted in his election as president of IPAA in 1936, and his re-election to that post in 1937, 1938 and 1939. He was a director of the IPAA and API, and had served as vice president of the API Division of Production. He was a member of the advisory board of the U. S. Bureau of Mines and served three years as chairman of the committee on petroleum and gas problems.

Charles F. Roeser

»

Harold Richard Delaney, 55, partner in the M. J. Delaney Company, drilling contractor, died July 1 in Dallas. Delaney, who was also a partner in the D.K.M. Company, was graduated from Notre Dame University in 1915.

»

Captain Victor H. Wilhelm, USNR, 63, died July 7 at the Long Beach Naval Hospital in California. Wilhelm had been inspector of Naval Petroleum Reserves in California since 1944.

He was active in the affairs of the California Conservation Committee; the Petroleum Division of the AIME, of which he was formerly national chairman; and the API. He entered active duty as a lieutenant commander in the Navy in 1941.

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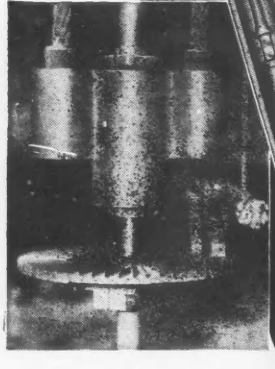

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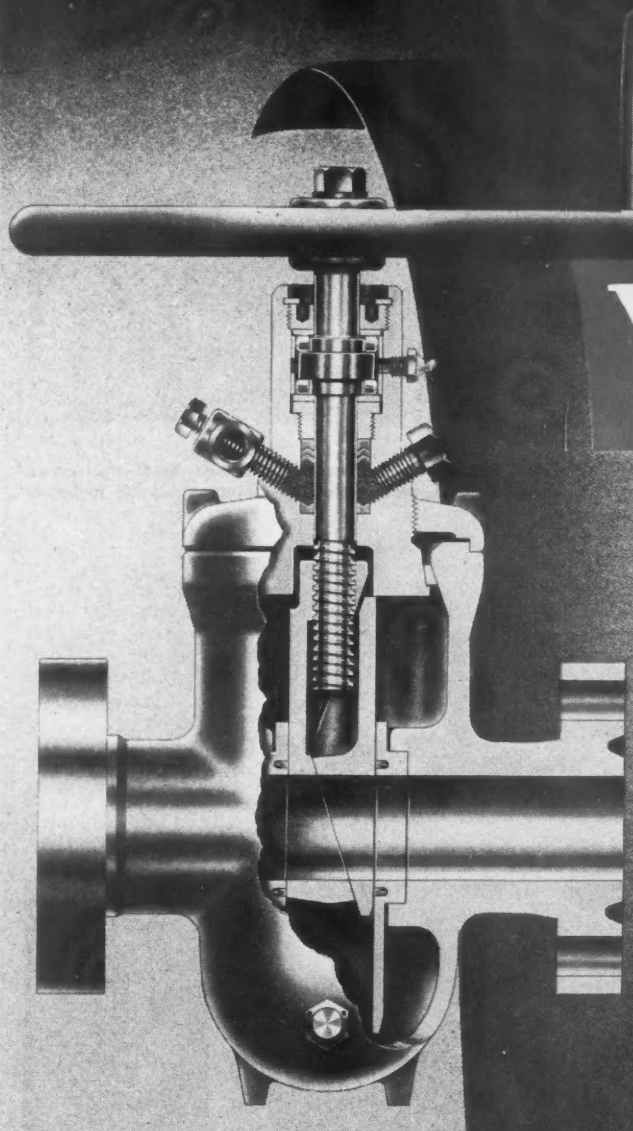

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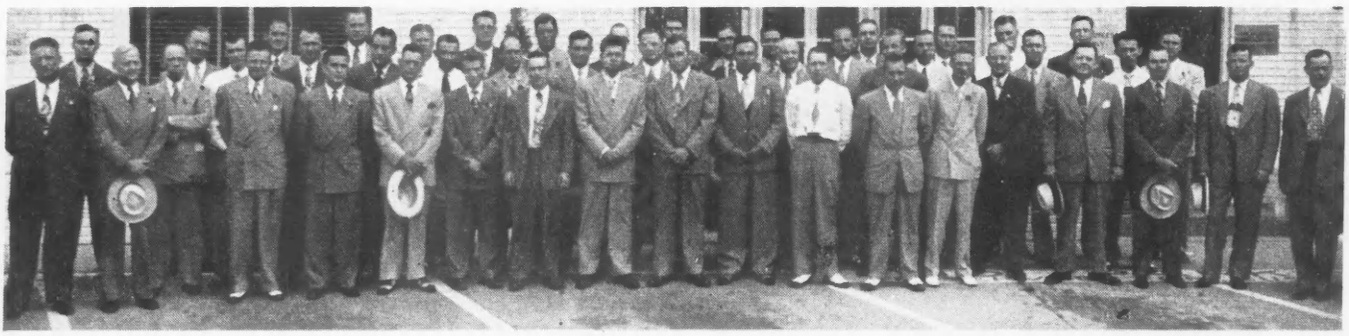

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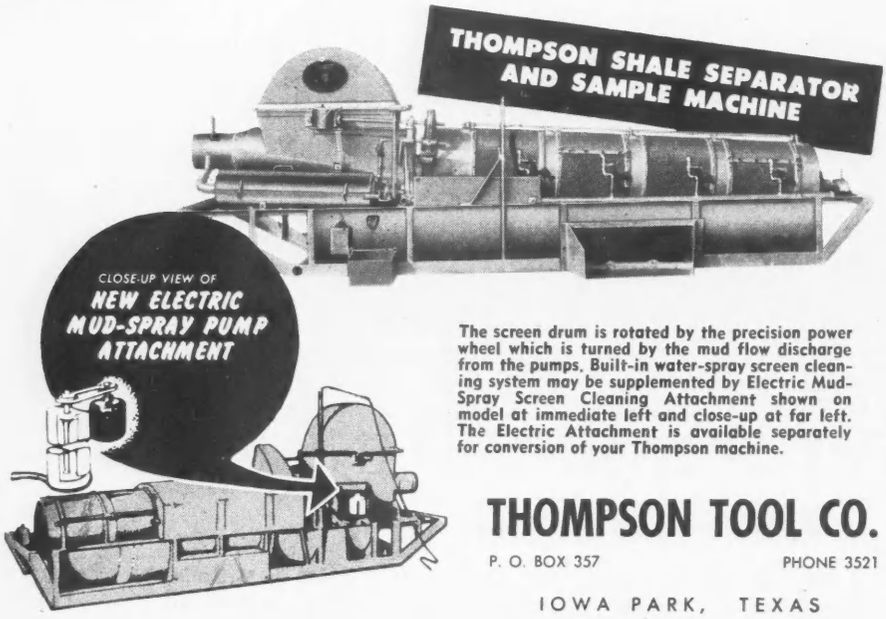

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IOWA PARK, TEXAS

HUGHES OFFICIALS MEET—Executives and field representatives of Hughes Tool Company, Houston, attended a two-state sales meeting at Enid, Okla. Leon B. Stinson, division sales manager for the Oklahoma-Kansas division, made the arrangements for the Enid meeting. In attendance from Houston were H. E. Rogers, vice president in charge of manufacturing; M. E. Montrose, vice president in charge of sales; G. J. Meyer, assistant to the vice president in charge of sales; E. R. Woodmansee, Tool Joint Sales; R. M. Goolsbay, Small Bit Sales; and Max B. Campbell, senior supply representative. M. G. Clark, special representative of the company from Pittsburgh, also was present. Others who attended the meeting included W. L. Hunter, northern regional manager, Oklahoma City; H. W. Harms, northern regional engineer, Oklahoma City; R. D. Hood, northern regional office manager, Oklahoma City; J. S. George, special representative, Tulsa; L. B. Stinson, division sales manager, Oklahoma City; P. A. Percy, district sales manager, Hutchinson; W. L. Barnes, district sales manager, Oklahoma City; R. R. Aulick, district engineer, Oklahoma City; W. W. Janes, district office manager, Oklahoma City; W. W. Cross, Perry; C. E. Freeman, Jr., Hutchinson; G. O. Griffin, Ardmore; W. G. Griggs, Duncan; R. M. Hall, Garden City; W. L. Haning, Oklahoma City; H. E. Harris, Oklahoma City; D. L. Hayes, Pratt; W. C. Hughey, Chickasha; J. E. McAdams, Oklahoma City; W. C. McAmis, Chickasha; F. W. Martin, Jr., Seminole; F. B. Mason, Perry; C. B. Morrison, Liberal; R. P. Moss, Duncan; L. G. Parrott, Oklahoma City; J. E. Petete, Hays; C. L. Pullen, Seminole; J. P. Purdy, Ardmore; T. J. Reaves, Winfield; G. R. Ritchie, Oklahoma City; O. R. Rogers, Seminole; Jack Ross, Oklahoma City; W. D. Sadler, Hutchinson; R. H. Skouby, Elk City; H. B. Smith, Perry; R. L. Valerius, Hoisington; G. A. Williams, Hays; J. G. Willis, Hutchinson; H. H. Allen, Hutchinson; A. L. Bailey, Oklahoma City; W. B. Garner, Oklahoma City; F. S. Smith, Oklahoma City; and J. T. Wright, Oklahoma City.

Griffin Becomes Manager of Welex Jet Houston Branch

W. H. (Bill) Griffin has been appointed sales manager of the Houston branch of Welex Jet Services, Inc.

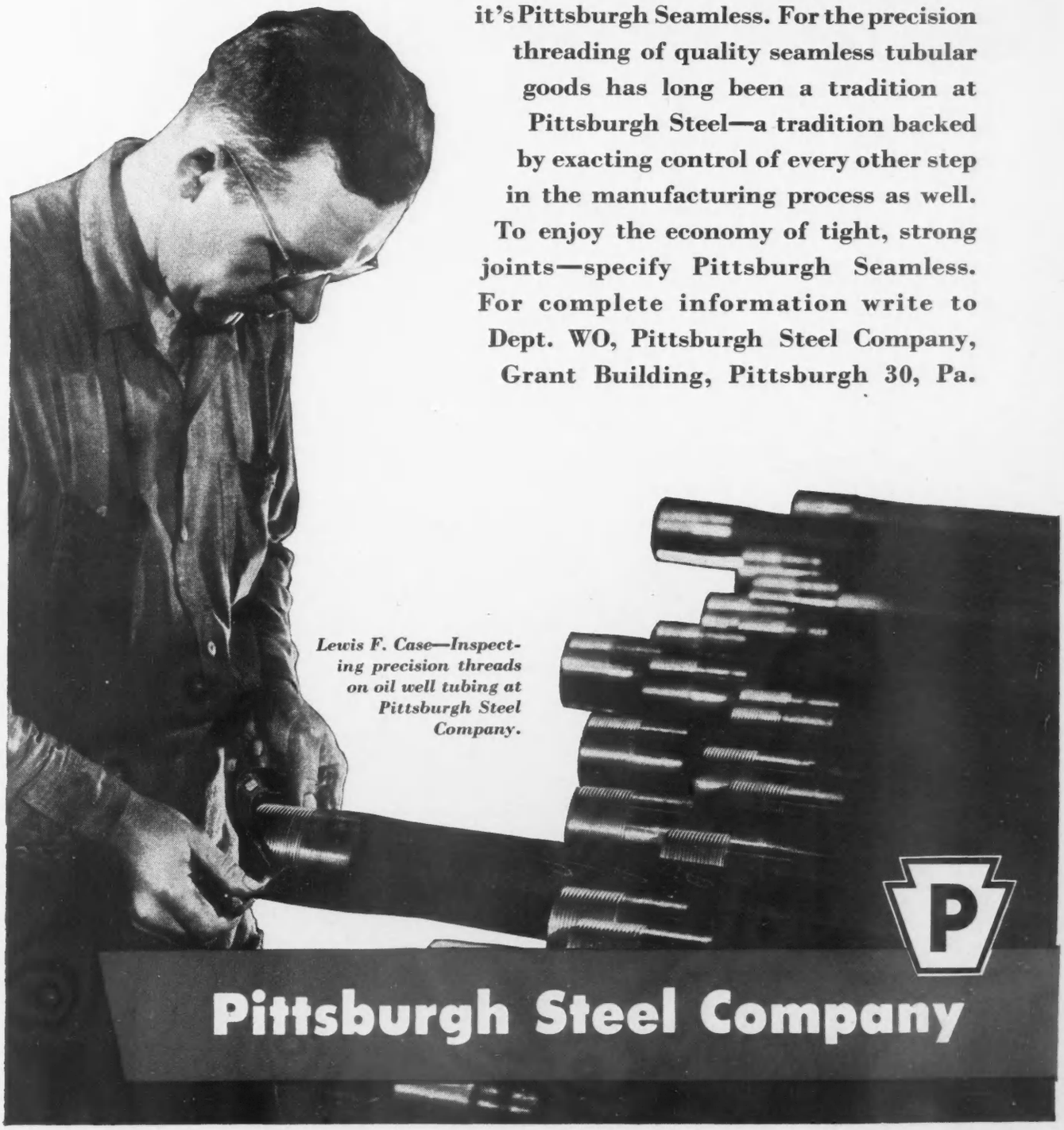
For the past 13 years Griffin has been associated with Baker Oil Tools, Inc., in Houston. As Baker's division engineer and manager of export sales he worked on special production problems in Venezuela, Trinidad, Colombia and Western Canada.

W. H. Griffin

Precision is Tradition at

Pittsburgh Steel

Your oil country tubing and casing will tong up tight with a minimum of leakers if it's Pittsburgh Seamless. For the precision threading of quality seamless tubular goods has long been a tradition at Pittsburgh Steel—a tradition backed by exacting control of every other step in the manufacturing process as well. To enjoy the economy of tight, strong joints—specify Pittsburgh Seamless. For complete information write to Dept. WO, Pittsburgh Steel Company, Grant Building, Pittsburgh 30, Pa.



Lewis F. Case—Inspecting precision threads on oil well tubing at Pittsburgh Steel Company.

Pittsburgh Steel Company

REPUBLIC STORE—Of brick and aluminum construction, the new Republic Supply Company store in Wichita Falls, Texas, has a capacity more than three times as great as the store it replaces. District headquarters in North Texas, the store is located on Scott Street in the industrial section of Wichita Falls.

For more efficient drilling...

Specify SPANG Cable TOOLS

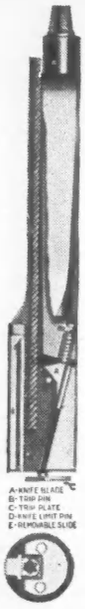


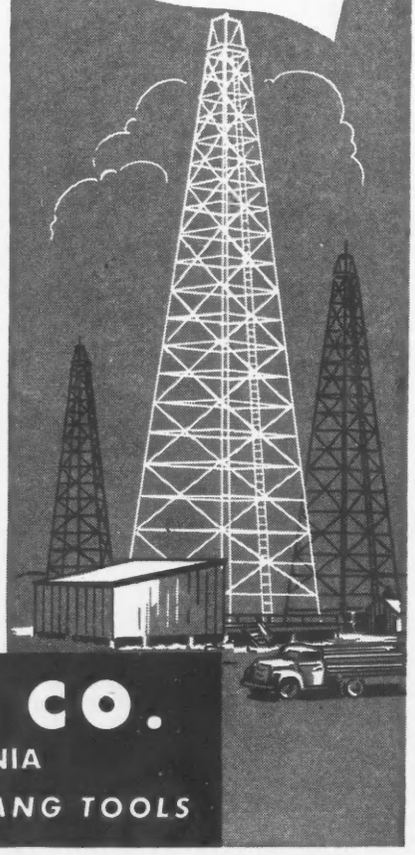
Fig. F450

SPANG

ECLIPSE UP-CUTTING WIRE ROPE KNIFE

A trip releases the blade when this tool comes in contact with the Rope Socket or Bailer. The outfit includes knife, rope socket, jars, and sinker. It cuts by jarring upward. Easy to use—just remove cotter key, take out slide anvil, place over line, and replace parts. Knife and anvil are specially hardened, assuring a quick, clean cut.

In all cable-system drilling, for efficiency and long wear, specify SPANG Tools.



SPANG & CO.

BUTLER, PENNSYLVANIA

YOUR DEALER SELLS SPANG TOOLS

Fluid Packed Pump Company Officials Travel Abroad

Sidney Shuman, general sales manager, Fluid Packed Pump Company, Los Nietos, Calif., has returned from an extensive business trip to Venezuela and Trinidad oil fields, and Mexico City. Before visiting the foreign countries,

Sid Shuman

J. B. Reilly

Shuman and his assistant, John Brennan, conducted the company's Mid-Continent sales meeting at Tulsa. From Tulsa Shuman went to Toledo and to New York. He flew to Caracas to attend a meeting of National Supply Export Corporation representatives.

J. B. Reilly, owner of Fluid Packed Pump Company and a prominent Rotarian, attended the Rotary International Convention at Lake Success and New York City, and then flew to Scotland on the Rotar-Y-Tour. In Europe, Reilly visited Norway, Sweden, Denmark, Belgium, France, Switzerland, Ireland and England.

In addition to Shuman and Brennan, Fluid Packed Pump representatives who attended the Mid-Continent sales meeting were Glen Peters, assistant to the sales manager; Harold Clayton, manager of material control; C. D. Newbolt, Shreveport; James E. Brewer and Harold Palmour, Kilgore, Texas; J. C. Sharp, Corpus Christi, Texas; D. A. McDaniel, Wichita Falls, Texas; A. Ledford Smith, Electra, Texas; Bill J. Lohmann, Brownfield, Texas; Glen Marchman, Laurel, Miss.; Charles Cameron, Midland, Texas; Grady Jennings, El Dorado, Ark.; Jack Clements, Houston; G. R. Newbolt, Tulsa; G. Ray Housley, Eldorado, Kansas; Earl R. Farmer, Drumright, Okla.; Lee Wise and O. F. Dunafon, Seminole, Okla.; Benny G. Wing, Duncan, Okla.; Leo C. Jones, Lyons, Kansas; L. W. Crow, Olney, Ill.; L. L. Converse, Salem, Ill.; Thomas B. Kennedy, Bradford, Penn.; and Wade Lanmon, Denver.

Julius Gaussoin, President
Silver Eagle Company

"We recommend FULLER Transmissions without reservations"

Julius Gaussoin, president of the Silver Eagle Company, Portland, Oregon, haulers of petroleum products in Oregon and Idaho, is high in his praise of Fuller Transmissions and Auxiliaries. He says:

"We recommend Fuller Transmissions without reservations. We are operating 40 Fullers over tough mountain grades pulling 72,000 lbs. without trouble. Main transmissions run in excess of 300,000 miles . . . auxiliaries over 500,000 . . . without major repairs—and after that mileage, usually only an occasional bearing replacement."

The average mileage of Mr. Gaussoin's trucks . . . all units are full truck and full trailer . . . is 11,300 miles per month. Three of his trucks have totaled more than 2,000,000 miles—over 700,000 miles each.

Mr. Gaussoin's statement is based on the Silver Eagle Company's long experience with Fuller Transmissions and Fuller Auxiliaries . . . an experience that has been shared by thousands who recommend them without reservation: to the driver for easier shifting . . . to the mechanic for simplified servicing . . . to the owner for longer work-life.

Fuller TRANSMISSIONS

FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO 13F, MICHIGAN

Unit Drop Forge Division, Milwaukee . . . SALES & SERVICE—BOTH DIVISIONS), 1060 E. 11th Street, Oakland 6, Calif.

BARRET

SPECIALIZING IN MAGNETIC SURVEYS

Contracts accepted for domestic and foreign projects, using the most improved instrumental and interpretative technique.

William M. Barret, Inc.

Consulting Geophysicists

GIDDENS-LANE BUILDING
SHREVEPORT, LOUISIANA

Red Top (Hydrostatic) BAILER

A QUICK, POSITIVE LOAD REGARDLESS OF FLUID LEVEL.
Ideal also for fishing small objects—widely used for drilling in (completing) wells, and for drilling cement or plastic plug overages.

REYNOLDS SPECIALTY COMPANY, INC.
SHREVEPORT, LOUISIANA, U. S. A
Office: 804 Erie St., Phone 7-7511
If no answer call 2-2023 or 7-2149
Factory: 2202 Greenwood Rd., Phone 2-2023
COMPLETE INSURANCE COVERAGE

Louisiana:
DELHI, Hayes Lumber Co.
JENA, Hayes Lumber Co.
RODESSA, Republic Supply Co.
Arkansas:
EL DORADO, Cox Supply Co.
Texas:
CORPUS CHRISTI, A. S. Baylor, Phone 2-2461
HENDERSON, J. C. Phillippi, Mgr. East Texas Div., Phone 9716-J1
HOUSTON, W. A. Swink, Phone Wydown 9-2858
SERVICE, Phone 3, Turnertown, or Phone 1010, Greggton
Kansas:
GREAT BEND, Moss Scranton, Phone 312

QUICK REPAIRS ON **CONDENSERS** and **HEAT EXCHANGERS**

If you need condenser or heat exchanger repairs in a *hurry* call us. We specialize in fast, high quality work.

25 Years Successful Experience

GULF ENGINEERING CO., INC.
"Service Not Promises"
1082 INGEBORG ST. HOUSTON, TEXAS
916 S. PETERS STREET NEW ORLEANS, LA.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Halliburton Marks 25th Year

A replica of the first cementing wagon used by the company's founder, Erle P. Halliburton, was constructed for the 25th anniversary of Halliburton Oil Well Cementing Company, Duncan, Okla.

Honored during the anniversary celebration were 22 employes associated with the firm since its 1924 incorporation. Halliburton, chairman of the company, presented each veteran employe with a diamond-studded lapel pin signifying a quarter-century of continuous service.

The growth of the company was reviewed by Halliburton at the anniversary luncheon. He traced its expansion from a one-man, borrowed team and wagon enterprise to today's worldwide business, with over 4000 employes.

Duncan's civic clubs held an appreciation banquet for Halliburton and the cementing firm he founded. The company is the town's chief industry.

The Halliburton veterans honored were J. O. Tillman, Charles Pressly and Allen G. Bell, Wichita Falls, Texas; W. A. Wallace and C. C. Hearn, Houston; Frank Kempf, Beaumont, Texas; Hubert Northcutt, Abilene, Texas; Joe K. Verser, Seminole, Okla.; J. E. Lacy, Wichita, Kansas; R. A. Godwin and Elmer T. Thomas, Norwalk, Calif.; R. R. Kelsey, Montalvo, Calif.; J. L. McBride, Shreveport; O. H. Kempf, Shawnee, Okla.; B. O. Johns, Sr., Harry Brigham, W. R. McClendon, T. A. Gilbert, Claud A. Murray, Irby B. Cate, William L. Weems, and Dan Thompson, Duncan.

Parkersburg Appoints Rathbone

W. V. Rathbone has been appointed vice president and general manager of The Parkersburg Rig & Reel Company. He will be in charge of manufacturing, engineering, and purchasing at all four Parkersburg plants located at Parkersburg, W. Va., Coffeyville, Kansas, Houston, and Pomeroy. Previous to his appointment to his present duties, he served as vice president in charge of manufacturing at Parkersburg.

GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. (Push-Button Faucet at slight additional cost.)

Gotkool
WATER CANS & COOLERS

GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . . .

GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet.

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

Accident Prevention benefits both the EMPLOYER *and* WORKER

More than a third of a century's specialization in Workmen's Compensation Insurance has convinced the Texas Employers' Insurance Association that it costs much less to prevent an industrial accident than to restore an injured worker to his job. That's why the Association has put so much stress on safety engineering. That's why the Association maintains the largest insurance safety engineering organization in Texas.

The Association's safety engineers have helped many Texas business and industrial firms reduce accident frequency and severity and thereby reduce insurance costs by: (1) Analyzing and reporting on accident causes, (2) Recommending the elimination of or guarding against job hazards, (3) Teaching safety on the job, (4) Advising with employers, and numerous other activities which have to do with preventing on-the-job accidents.

Does your insurance carrier offer such a complete safety engineering service?

COMPLETE SERVICE

The Texas Employers' Insurance Association maintains facilities whereby employers of labor in Texas can secure complete and highly specialized Workmen's Compensation Insurance Service, including:

- Nineteen district service offices.
- Proved financial responsibility.
- Qualified rating and underwriting "know-how."
- Prompt handling of claims.
- Texas' largest insurance safety engineering organization.
- Insurance at cost to Texas employers.

TEXAS EMPLOYERS INSURANCE ASSOCIATION

Home Office: DALLAS • *District Offices in:* ABILENE • AMARILLO • AUSTIN • BEAUMONT • CORPUS CHRISTI • DALLAS • EL PASO • FORT WORTH
GALVESTON • HARLINGEN • HOUSTON • LUBBOCK • MIDLAND • PORT ARTHUR • SAN ANTONIO • SHERMAN • TYLER • WACO • WICHITA FALLS

HOMER R. MITCHELL, *Chairman of the Board* A. F. ALLEN, *President*

WAREHOUSE OPENED—Mud Products, Inc., Tulsa, has opened a warehouse at Duncan, Okla., to facilitate the handling of drilling muds and chemicals. The warehouse is under the direction of Ben R. Bourland, division manager.

DAN L. CLARK W. M. AVERILL RUPERT COX

DAN L. CLARK
DRILLING
COMPANY

Drillers of
OIL AND GAS WELLS

POWER
AND
STEAM
RIGS

WILSON BUILDING
CORPUS CHRISTI, TEXAS

Telephones
Local 7746—7747 Long Distance 95

Baash-Ross Company Establishes Rocky Mountain Headquarters

Baash-Ross Tool Company has opened its Rocky Mountain headquarters on East Yellowstone Highway in Casper, Wyo. Representatives of the company's Sales and Service departments will be stationed at Cutbank, Mont., and Grand Junction, Colo., in addition to the Casper address.

District sales manager is Ed Gearke, who will be located at Casper. Gearke was formerly with Baash-Ross in California and Oklahoma City. Gene Gardner is the sales representative at Casper. R. L. (Don) Bowcutt, representative at Cutbank, is experienced in mining and petroleum engineering activities in Montana and the Rocky Mountain area.

O. L. Wooten

Ed Gearke

O. L. Wooten, manager of the Rocky Mountain Service department, Casper, worked in the Oklahoma and Illinois areas formerly. Ralph Hall, formery in the California area, will be stationed at Casper. Working with him will be Johnny Starner, who has 20 years Rocky Mountain oil field experience.

Service representative at Grand Junction is Frank Myers, who has worked in the Rocky Mountain area five years, and was previously engaged in oil well drilling in Oklahoma.

Supervising warehouse activities at Casper is Cliff Robinson, who has been associated with production and drilling operations of major companies in the Rocky Mountain area.

Byron Jackson Pump Division Advertising Manager Is Named

T. R. (Bob) Colville, has been appointed advertising manager of the Pump division of Byron Jackson Company of Los Angeles.

After serving 3½ years in the service, Colville worked in the Advertising division of the Chemical department of the General Electric Company until last fall. Prior to the war, he was assistant program director for an eastern radio station. Colville was graduated from Syracuse University.

T. R. Colville

REMOVE THE CAP . . . REPLACE THE BEAN

FASTER THAN CONVENTIONAL METHODS!

O-C-T PRODUCTION CHOKES GIVE YOU...

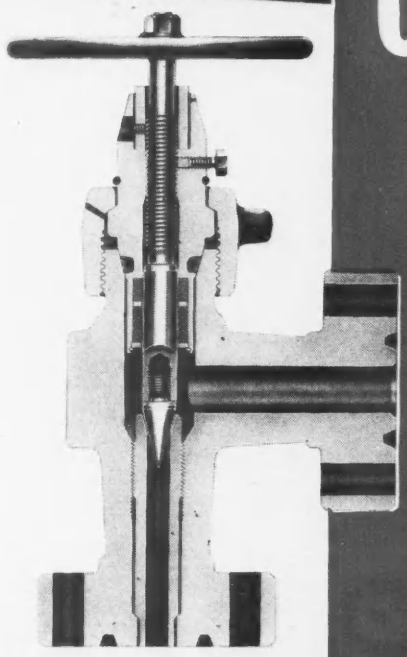
Economy — provided by incorporating an enclosed stem thread, replaceable stem point and "O" ring bonnet seal unit.

Speed — provided by the hand-tight flow cap; easily and quickly removed to change beans.

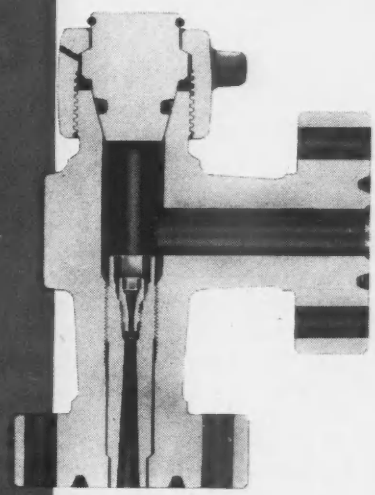
Flexibility — provided by the single body design which is convertible to either positive or adjustable flow.

Strength — provided by the rugged and compact design with strength to withstand pressures far above the ratings.

Simplicity — provided by rugged, interchangeable parts.



JW CHOKE — The enclosed stem thread and packing unit provides a short, compact adjustable choke.



PC CHOKE—This positive choke accommodates beans from .0156" to 1" in either FC 142 PV Type or FC 140 Type.

In the new JW (Adjustable) Choke and PC (positive) Production Choke O-C-T engineers have incorporated a hand tight flow cap design which materially speeds up the bean replacement operation. This cap holds full body pressure when only hand tight. By simply removing the hand tight flow cap, the bean replacement can be accomplished in a fractional part of the time required by conventional methods.

In addition, this same hand tight flow cap makes the new O-C-T Production Chokes easily and quickly converted from adjustable to positive chokes. Thus, a well may be cleaned with a JW Choke and quickly switched to a PC Choke for steady production.

Added economy is provided in the new O-C-T JW Adjustable Chokes by incorporating an enclosed stem thread, replaceable stem point and an "O" ring bonnet seal unit. The same choke body accommodates the PC Positive Flow Cap and a variety of flow beans.

Check the other features of this new O-C-T Production Choke. Talk to your O-C-T Representative or write for complete mechanical details.

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

Oil Center Tool Co.

P. O. Box 3091, Houston, Texas

Export Representatives: Venezuela, Colombia, Peru, and Ecuador—Berry & Hall, Apartado No. 304, Maracaibo, Venezuela—Sterling Areas—Le Grand, Sutcliff & Gell, Ltd., Southall, Middlesex, England. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston 1, Texas.

COMPOUNDED and PRESCRIBED to PREVENT GALLED THREADS

Unless thread compounds are treated very much like physicians' prescriptions, they don't contain *all* properties required for complete protection against galling. A haphazard mixture *won't do* the job.

At WECO, thread compounds *are* treated like prescriptions. Carefully selected materials, each chosen for its ability to perform a certain vital function, are skillfully blended into compounds of the highest protective quality. Pure metallic bases . . . zinc in WECO No-Gall, lead in WECO Steel-Aid . . . are held in solution by neutral oils and grease binders that prevent any tendency to harden; tacky additives provide for adherence to wet, slick joints. *No compressible fillers are employed.*

GET THE FACTS on thread compounds from your WECO representative. He can show you why WECO compounds . . . Steel-Aid or No-Gall . . . provide unequalled protection. He'll also be happy to tell you about WECO Hi-Speed Seal, a permanent, non-hardening seal for easing, tubing and other threaded connections.

WECO THREAD COMPOUNDS ARE AVAILABLE AT YOUR SUPPLY STORE

WELL EQUIPMENT MFG. CORP.
Subsidiary of Chiksan Company
Houston 1, Texas
Exclusive Sales Representative Outside Mid-Continent Area
CHIKSAN COMPANY
Brea, Calif. New York 7
Export Sales: CHIKSAN EXPORT COMPANY, Brea, Calif. New York 7

WECO
Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Leo E. Whitson

L. D. Perryman

Sterling Packing and Gasket Adds Two Sales Engineers to Staff

Leo E. Whitson and L. D. Perryman have joined the staff of Sterling Packing and Gasket Company as sales engineers.

Whitson, a graduate mechanical engineer, will be stationed in the Houston office, and will operate in the Texas Gulf Coast area.

Perryman will represent the company in South Louisiana, working out of Lafayette. He was formery with Cameron Iron Works and W-K-M Company.

John A. Carter Is Elected President of Oakite Products

John A. Carter, who has been with Oakite Products, Inc., New York, for 34 years, has been elected president of the company. He served as assistant to the president and, since 1947, as general manager of the firm.

John A. Carter

D. C. Ball, founder and former president, was elected chairman of the board. David S. Ball, former vice president, was named to the new office of first vice president. Re-elected were H. Liggett Gray as vice president, James Beckett as treasurer, and David A. Hearn as secretary.

Silver Star Is Awarded to Lane-Wells Service Operator

Carl Leidecker, electrolog operator with Lane-Wells Company, has been awarded the Silver Star, the nation's fourth highest award for valor in combat. The medal was presented in recognition of Leidecker's heroic action in extinguishing a fire "that started as a result of a Japanese shell hitting an ammunition dump on Tinian, Marianas Islands, July 24, 1944," according to the citation. He was credited with saving the lives of many of his comrades in the U. S. Marine Corps.

Before he entered the service, Leidecker worked in Texas oil fields for five years. He joined Lane-Wells after his release from the Marine Corps in 1946, and has worked in the Los Angeles district.

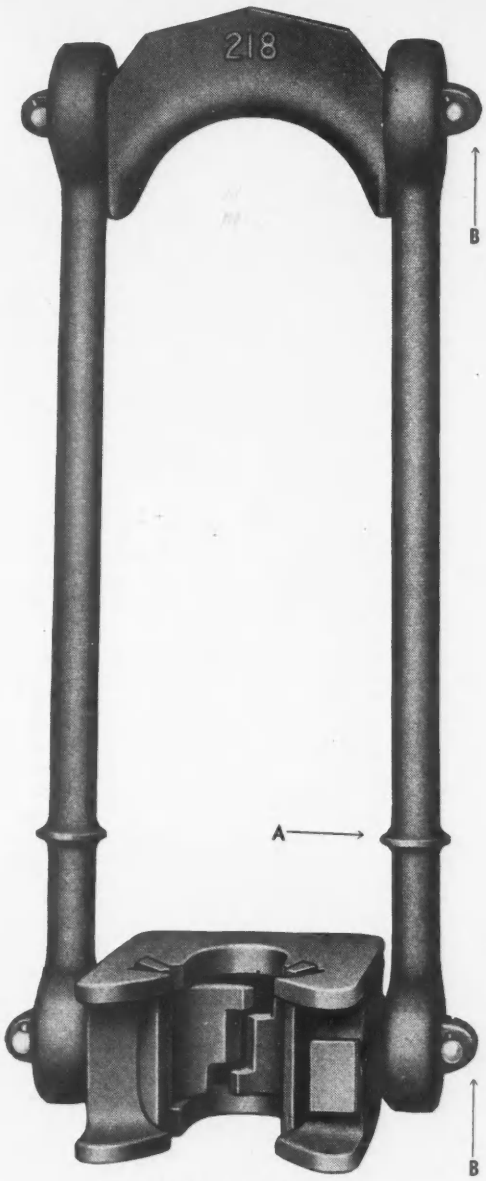


Figure 1: Open position showing details of the locking device.

Faster, Easier Safer Operating

RATIGAN NO. 218 TUBING ELEVATOR

The new, improved Ratigan No. 218 Tubing Elevator was designed to fill an urgent demand for a faster, easier, safer operating elevator for pulling tubing, especially where gin poles and portable rigs are used. It is a single bail elevator and can be used on either side. It operates just as fast and smooth as a rod elevator.

The locking device is fast, positive and absolutely safe. It is opened instantly (figure 1) from the front by pushing the plunger ("C" figure 3); or from the back by pulling the curved handle (figure 3).

A safety ring ("A" figure 1) on the reins has been added to help keep the operator from gripping the reins too close to the body of the elevator and thus help reduce to a minimum, serious hand injuries. Another feature is the separate arch top of the bail. This feature makes it possible to change quicky to different size elevators, and also to different length reins. This can easily be done by the use of Ratigan's quick-change safety locking pins ("B" figure 1).

This new elevator has been tested to 200,000 pounds on an Olsen pulling machine without showing any signs of weakness. It also has been thoroughly tried out in the field under all operating conditions, and has proved very popular with the men who use it, who say it is much faster, easier and safer to operate than the old type elevator.

It can be furnished to take either 2", 2½" or 3" tubing. When ordering, be sure to specify the size desired.

Developed and Manufactured By

J. P. RATIGAN, Inc.

1213 Santa Fe Avenue, Los Angeles 21, California

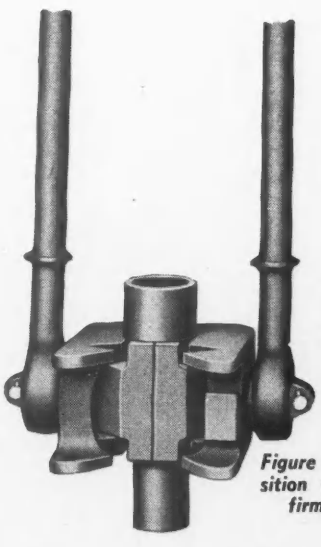


Figure 2: Closed position with tubing firmly in place.

WEIGHT, 143 POUNDS
CAPACITY, 100 TONS

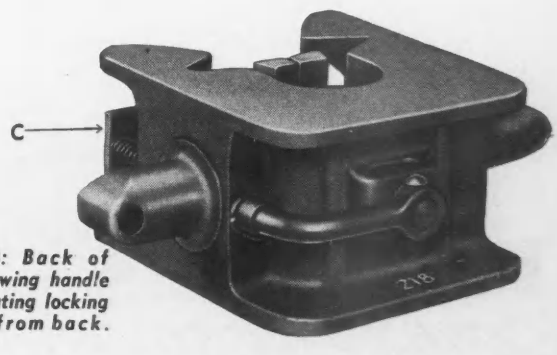


Figure 3: Back of body showing handle for operating locking device from back.

Extra Speed

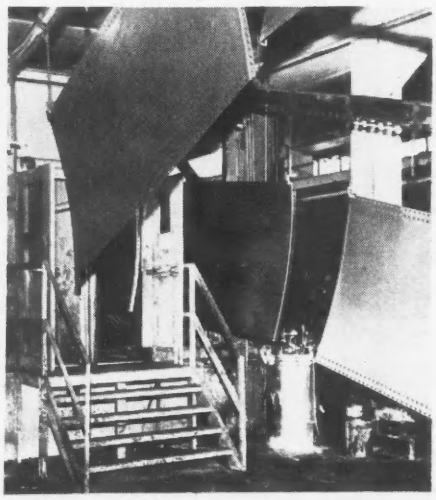
THREADING 1" to 2" PIPE

RIDGID No. 65R
is semi-automatic, sets to pipe size in just 10 seconds

● The RIDGID 65R is so handy and efficient that it's actually a pleasure to use. In just 10 seconds you're ready to cut perfect threads on 1," 1¼," 1½" or 2" pipe. Workholder sets instantly—only one screw to tighten, no bushings. With the self-contained RIDGID 65R you don't have to bother with extra dies—one set of high-speed steel chaser dies gives you accurate threads on any kind of pipe or conduit, always—easily. Every 65R is factory-tested. Buy from your Supply House.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL CO. • ELYRIA, OHIO

EQUIPMENT and SERVICE SUPPLIERS' NOTES



NEW PAINTING METHOD—The booth shown at left houses the new electrostatic spray used by Butler Manufacturing Company to paint its bolted steel oil storage tanks. In the process, atomized paint is sprayed into an electrostatic field. Paint particles receive a negative electrical charge which causes them to be attracted to the positively charged tank sheets. All metal surfaces attract the same amount of paint regardless of area. After the sheets are chemically washed to prevent peeling and chipping, both prime and finish coats are applied electrostatically.

Johnston General Service Manager Is Stationed in Permian Basin

Tommy Johnston, general service manager of M. O. Johnston Oil Field Service Corporation, Los Angeles, is currently stationed at Odessa, where he is assisting the Johnston Oil Field Service Corporation of Houston in field operations.

Tommy Johnston

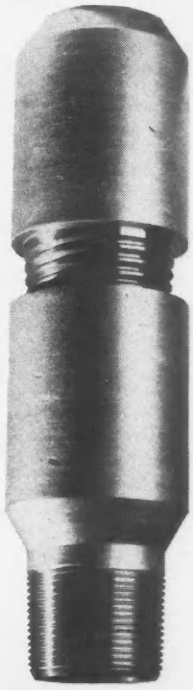
In a move to expand services in this territory, the Johnston Texas company recently purchased stores at Andrews, Kermit, Midland, Odessa, San Angelo, and Snyder, Texas, and Hobbs, N. M., from the Johnston California company.

Ideco Opens Lafayette Store, Names George Fox Manager

George Fox has been appointed manager of a new International Derrick & Equipment Company store opened at Lafayette, La. The store will be operated under the direction of J. L. Morgan, Louisiana district manager. J. W. Terrell and Jimmie Norton, sales representatives, have been transferred to the Lafayette area.

N. J. (Tiny) Herman, technical service engineer for the International Derrick and Equipment Company, has been transferred to Tulsa. He will office in the Kennedy Building.

Select High Alloy Steel
LONGHORN
TUBE JOINTS



Features:

1. Eliminate wear and tear on tubing threads
2. Save time on round trips
3. Prevent crushed tubing by tong action
4. Have full opening for bottom hole tools
5. Are 100% interchangeable

LONGHORN TUBE JOINTS save money in well completion and reworking operations because they permit varied use of tubing where expensive strings of drill pipe might otherwise be rerequired.

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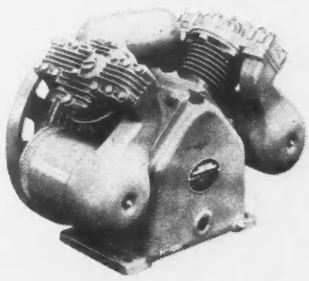

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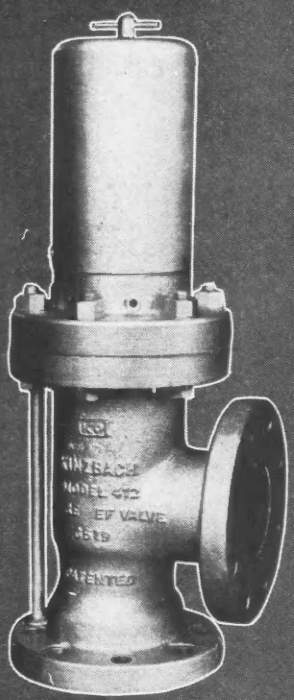

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EQUIPMENT and SERVICE SUPPLIERS' NOTES

Cavins Names Sales Representative In California, Rocky Mountains

R. B. (Bob) Block has been named drilling sales representative in California and the Rocky Mountain area for The Cavins Company. He will handle the Cavins Multi-Surge Junk Snatcher, a new hydrostatic, multiple-action junk pick-up tool that runs on drill pipe or tubing.

R. B. Block

Block started with The Petroleum Midway in 1921 as a roughneck. In 1926 he went to Colombia to work for The Tropical Oil Company as a driller, and was later transferred to Peru. He resigned as drilling superintendent in 1947 after 21 years of service. While with International Petroleum Company, he worked in Peru and Ecuador, where he drilled the first rotary well for IPC.

Henry H. Paris Opens Sales Office In Mid-Continent; Manager Named

Henry H. Paris, president of Henry H. Paris Distributor Inc., Houston, has announced the opening of a Mid-Continent sales office in the Howard Building, Tulsa. J. H. Eustice, who will be in charge of the new office, was formerly with W. C. Norris Manufacturer, Inc. Territory to be served by Eustice from the Tulsa office includes Oklahoma, Kansas, northern Arkansas, and the Texas Panhandle.

J. H. Eustice

Bovaird Advances Bus Bartheld To Representative at Tulsa

L. W. (Bus) Bartheld, for many years West Texas district manager of Bovaird Supply Company at Odessa, Texas, has been made Tulsa representative of the company, it was announced by Davis D. Bovaird, president.

L. W. Bartheld

Bartheld has been with Bovaird 13 years. Prior to that he was with Oil Well Supply Company nine years, starting in 1927 as a part-time employee while attending the University of Oklahoma, from which he graduated in 1929 with a degree in business administration.

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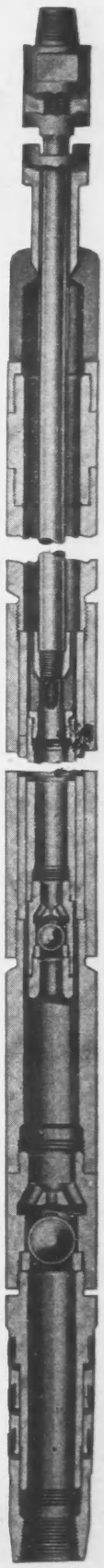

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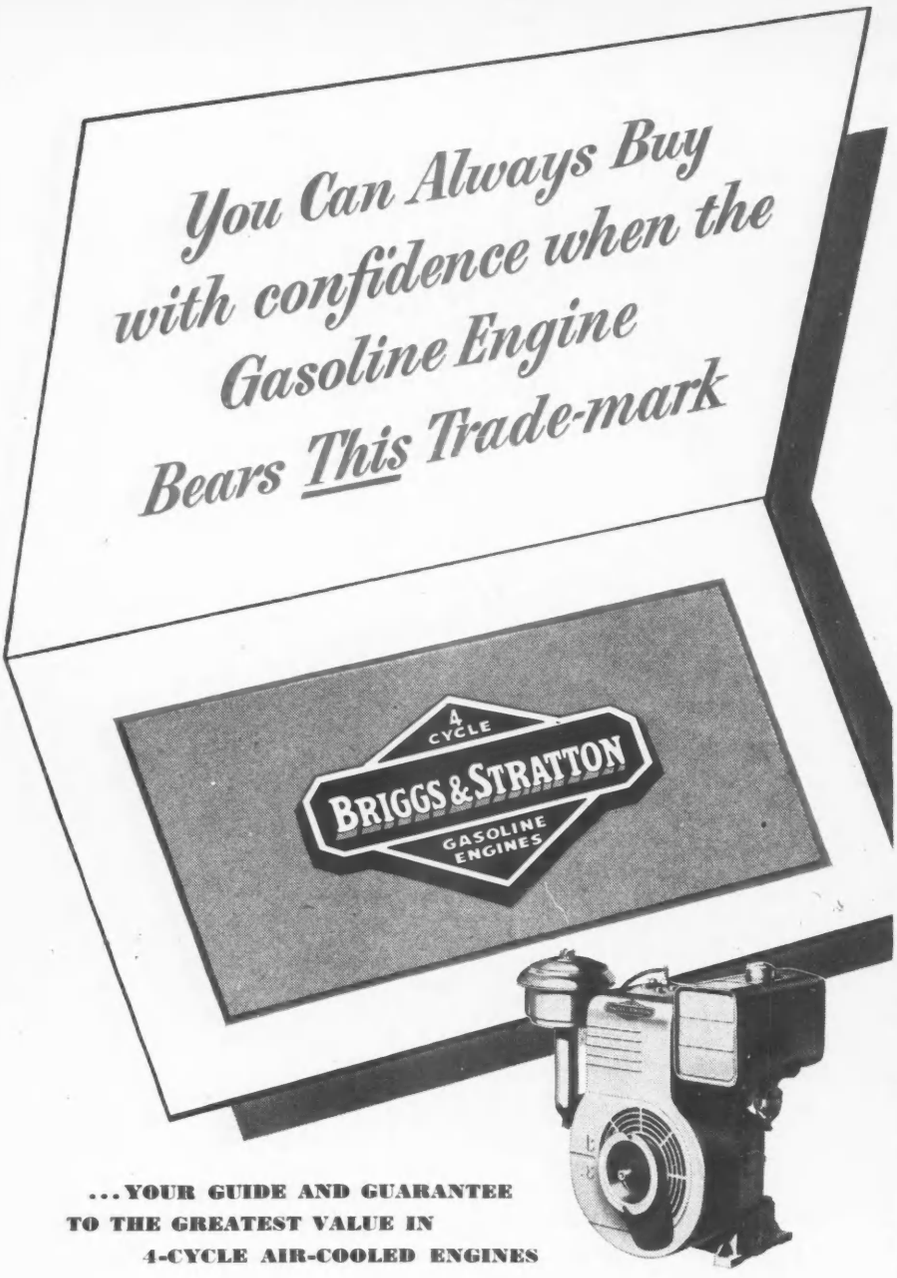

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EQUIPMENT and SERVICE SUPPLIERS' NOTES

Hobart C. Ramsey

Clarence E. Searle

Worthington Pump Makes Changes In Corporation Executive Staff

Executive changes announced by Worthington Pump and Machinery Corporation include the election of Clarence E. Searle as vice chairman of the board, Hobart C. Ramsey as president, Edwin J. Schwanhausser as executive vice president, and John J. Summersby as vice president in charge of sales.

Searle became associated with the corporation in 1932 as vice president in charge of sales and has been president since 1945. He will continue as chairman of the Management Committee.

Thomas J. Kehane

John J. Summersby

Ramsey, executive vice president since 1945, joined the corporation in 1920 as sales engineer in the Export department. He later became manager, Foreign department and vice president in charge of engineering and manufacturing.

Schwanhausser, prior to his election in 1945 as vice president in charge of sales, was with the Manufacturing department. He joined the company in 1915 as an engineer at the Harrison Works.

Summersby, who has been assistant vice president and general sales manager since 1934, joined the organization in 1916.

Thomas J. Kehane was made assistant vice president and general sales manager. He has been with the company since 1915, when he joined as an office boy. He was made commercial vice president, Pacific Coast, in 1944, and for the past two years has served as Pacific Coast regional vice president of the Navy Industrial Association.

Grove Opens Tulsa Office

Grove Regulator Company, Oakland, Calif., has opened a new sales office at 310 Thompson Building, Tulsa 3. The office will operate as a subsidiary of the division office at Houston.

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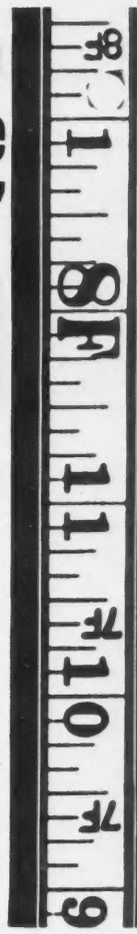

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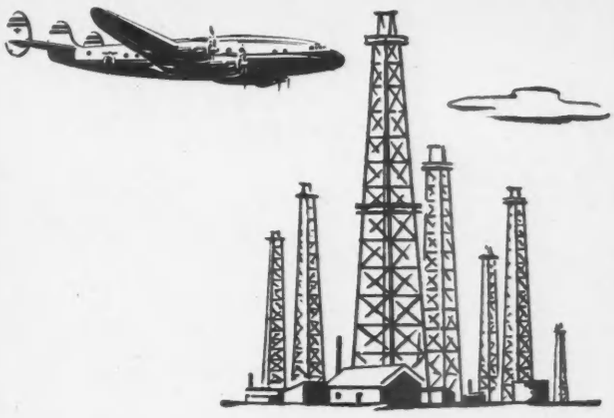

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EQUIPMENT and SERVICE SUPPLIERS' NOTES

Wilbur Squyres

Herm Schaller

Eastman Oil Well Survey Company Announces Transfers, Promotions

Herm Schaller has been named division sales manager of the Rocky Mountain - Mid-Continent division of Eastman Oil Well Survey Company, with headquarters in Denver. Schaller, formerly sales representative in Long Beach, Calif., has been with the Eastman organization for two years; his background prior to that time includes a year as a development engineer for The Texas Company in Long Beach and three years as a field engineer with the Conservation Committee of the California Oil Producers. A graduate of the University of Southern California, he holds a master's degree in petroleum engineering.

J. C. Staton

Heading Eastman's new office in the International Trade Mart Building in New Orleans is Frank Wilbur Squyres, district sales manager. Squyres attended Rice Institute and the University of Houston, and before the war was a field engineer for Eastman. He served in the Navy during World War II, and before returning to work for Eastman, was affiliated with the Gulf International Corporation.

New district sales manager for Oklahoma is Robert W. Sneed, of the company's Oklahoma City office. Sneed, who started with the company as a sales and service engineer two years ago, has also worked in Casper, Wyo., and Lafayette, La.

Gulf Coast field superintendent is J. C. Staton, whose headquarters will be in Houston. Staton has had eight years' service with Eastman, and has served as field engineer for the Lafayette and Corpus Christi offices.

Additional changes in the Sales department include the transfer of David P. Neill to Odessa from Victoria, Texas. Neill's past experience includes four years as field manager for R. H. Hawn Oil Company and seven years as field manager for Buckingham Oil Company in Corpus Christi, Texas.

Replacing Neill at Victoria is Pete T. Bush, sales and service engineer, who has been with the Eastman company for a year. He is a graduate of the University of Tennessee, where he received a

EQUIPMENT and SERVICE SUPPLIERS' NOTES

degree in commerce and business administration.

New sales representative at Longview, Texas, is Michael A. O'Bannon. Formerly a service engineer for Mud Control Laboratories in Oklahoma City and for Baroid Sales division in Tulsa, O'Bannon is a graduate in petroleum engineering from the University of Kansas.

Lee Fields is new sales representative at Houston. He was formerly associated with the A-1 Bit and Supply Company, and prior to that, with the Greenhead Bit and Supply Company.

Sales and service engineer at Alice, Texas, is Claude A. Collins, whose past experience has been with the Morris Core Drill Company of Abilene, Texas, and with Buda Engine and Equipment Company. Collins is a graduate engineer from the University of Houston.

Hawthorne Representative Tours Oil Fields from Texas to Canada

Earl Weaver of Herb J. Hawthorne, Inc., has returned to Houston from a 5000-mile trip from South Texas to Edmonton, Alberta, Canada. Weaver inspected Hawthorne Replaceable Rock Cutter Bits in action in the fields, and reported on performance data obtained from seismograph parties using the Hawthorne tool.

Earl Weaver

During the course of his trip, Weaver talked with parties drilling shot holes in the red beds and blue shale of Oklahoma, the sandstone and limestone stringers in North Texas, the cap rock in the Panhandle, the caliche beds in West Texas, the lime sandstone in eastern New Mexico, the gravel beds in Wyoming, the thick sandstone buttes in Montana and the glacial drifts of Alberta.

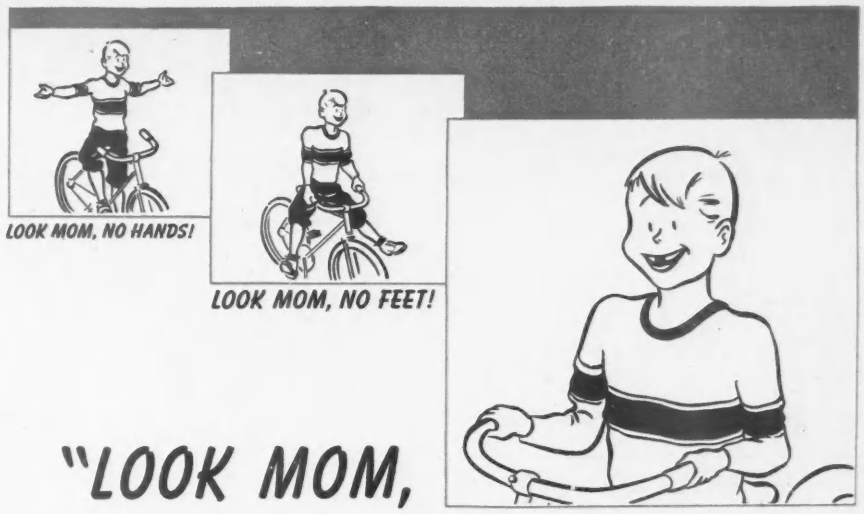
Weaver's report to the Hawthorne organization included comprehensive information on performance of the company's bits in each of the areas visited.

Geolograph Company Elects Brown

H. T. Brown, secretary-treasurer of the Geolograph Company, Oklahoma City, has been elected a director of the company. Rex Ballinger has been transferred from Oklahoma City to Wichita Falls, Texas, where he will open a North Texas district office and John McNatt has been transferred from Oklahoma City to Casper, Wyo., to assist Fred Miller, district manager for the Rocky Mountain area.

Porter Acquires Jarecki Company

H. K. Porter Company, Inc., Pittsburgh, has completed its acquisition of Jarecki Manufacturing Company, Erie, Penn. Jarecki manufactures valves and fittings and operates 27 stores in the Mid-Continent fields.



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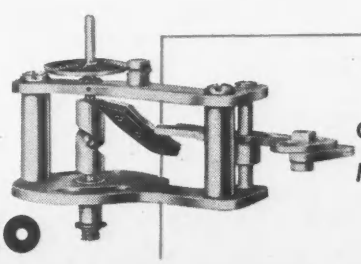

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EQUIPMENT and SERVICE SUPPLIERS' NOTES

E. D. McMurry

B. F. Krause

Krause and McMurry Are Promoted To Key Positions by Garrett

B. F. (Fritz) Krause was appointed manager of the Gulf Coast division for Garrett Oil Tools, Inc. Krause will be in charge of sales and service of GOT-OLSCO gas lift equipment in the Gulf Coast area. He will headquarter in Houston.

E. D. McMurry, former Gulf Coast manager, was appointed special representative to work with all GOT-OLSCO district and division representatives in designing gas lift installations to meet specific well and field conditions. He will also be in charge of the Export division of the company, and will make regular trips to South America and other areas outside the U. S.

Black, Sivalls & Bryson Opens Stocking Points, Names Manager

Stocking points have been established at Snyder, Texas, and Mears, Mich., by Black, Sivalls & Bryson, Inc. The Snyder office will handle field-welded steel storage tanks and oil and gas separators, and the Mears installation will have welded steel storage tanks and treaters.

William A. Watkins, sales and service man of the Lafayette, La., branch, has been transferred to Snyder, and will be in charge of sales there. All Scurry County business will continue to be routed through the Lubbock branch.

The Mears office will serve the Pentwater field area.

W. W. (Woody) Pyeatt has rejoined Black, Sivalls & Bryson and will direct the company's New Orleans sales office. Until a year ago, Pyeatt was connected with the Engineering department at Oklahoma City before engineering operations were centralized in Kansas City.

Office Manager Is Appointed

F. Wayne Yates, former Tulsa office manager for Denver-Gardner Company, is now office manager for Knight Manufacturing and Supply Company at Tulsa.

SITUATIONS WANTED

■ Thoroughly experienced production and drilling supervisor capable of taking charge either or both operations. Also production engineering education and experience. Mr. C. H. Duffy, Box 95, Golden, Texas.

■ Aggressive, graduate Petroleum Engineer. Six years varied field experience. Presently employed as drilling and production superintendent by independent drilling contractor and operator. Desires to make change. Address: Box 36W, c/o World Oil, Houston, Texas.

New Books, Maps and Movies

Limestone Pore Space Study

The illusion of a slow-motion trip through the pores of a rock sample, in which the pores open and close before your eyes, is created by a motion picture produced by the research laboratories of Stanolind Oil and Gas Company.

Chiefly a close-up study of actual reservoir limestones, the film also shows a comparison of limestone with a uniform sandstone. The picture was produced as a result of experimental work with the "Cinematome." This is an instrument that successively grinds .0001 inch of rock off the face of the core and then takes a single frame picture of the rock face after each cut. When the film is projected at motion picture speed, the rock seems to melt away, and the viewer gets the impression that he is actually traveling through the rock itself.

A running commentary explains the experimental procedure, identifies and gives physical constants for the samples, and discusses some of the problems involved in petroleum reservoir technology.

The film may be secured on loan without charge, from Stanolind Oil and Gas Company, P. O. Box 591, Tulsa, Attention: Research Department.

Aeromagnetic Maps

Results of the first detailed magnetic survey conducted over water are contained in the U. S. Geological Survey's aeromagnetic maps of part of the Gulf of Mexico. Data consists of a short text and two aeromagnetic maps of about 9000 square miles of the Gulf of Mexico off the coast of Texas and Louisiana.

The aeromagnetic survey, a cooperative project of the Office of Naval Petroleum Reserves, the Naval Ordnance Laboratory and the Army Air Technical Services Command, was undertaken to determine whether a satisfactory survey could be made over water by using Shoran, a short-range radio navigation aid, to guide and locate the surveying aircraft. The resulting map reveals broad magnetic features which are thought to be related to structures in the basement rocks essentially parallel to the coast and at depths of a few tens of thousands feet.

U. S. Geological Survey, Washington 25, D. C.

Radioactivity Surveys

A recommended practice has been drawn up for a standard radioactivity log form for use in recording the data obtained from radioactivity surveys of deep wells. The new radioactivity log embraces all information that is expected to be pertinent now or later, in order to avoid the mistakes of early-day electrical logging when various forms were used, many of which lacked sufficient information to interpret in the light of later developments.

The recommended practice was sponsored by the API Topical Committee on Production Technology and was developed originally by the Pacific Coast Division Subcommittee on Core Analysis and Well Logging.

American Petroleum Institute, Division of Production, 1208 Continental Building, Dallas, 50 cents.

Geologic Map

Perry County, Ohio, is the subject of a new geologic map. The map is 26 x 29 inches, colored, scale 1⅛ inches equals one mile.

This map shows the areas of the county underlain by the Logan and Maxville formation of the Mississippian System and the Pottsville, Allegheny and Conemaugh series of the Pennsylvanian System. The outcrops of the Middle Kittanning coal and the Brush Creek and Ames limestones are shown as well as the Illinoian and Wisconsin glacial boundaries. Structure contours on the base of the Middle Kittanning coal are also shown. A generalized section for the county appears in color.

Ohio Geological Survey, Orton Hall, Ohio State University, Columbus 10, $1.

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Fig. 142
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Underreamer
Collapsed
(Left)
See cutter views (left). Collapsed for "free and easy" in-and-out of hole. Expanded for underreaming operation. No jarring into casing . . no broken cutters.
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PAA

Engineering Feat

The elderly guest of honor was seated across the table from a lovely lady wearing one of the latest strapless, clinging type of evening gowns. Despite the conversation of his charming neighbors, the guest could not keep his eyes from the contours revealed and suggested. Finally he leaned across the table to address the lady.

"Pardon me, madam," he began. "I just had to ask you what keeps that dress up?"

"Just two things," she replied. "Your age—and my discretion."

Time for a Change

Sheriff: "Did you catch that automobile thief?"

Deputy: "He sure was a lucky guy. We had chased him a mile when our 1000 miles were up and we had to stop and change oil."

It's a Long Way to Go

Hiram walked four miles over the hills to call on the girl of his dreams. For a long time they sat silent on a bench by the side of her log cabin home; but after a while the moon had its effect, and Hiram sidled closer to her and picked up her hand.

"Marthy," he began, "I've got a good clearin' over thar an' a team an' wagon an' some hawgs an' cows an'" . . . Here he was interrupted by Martha's mother who had awakened. "Martha!" she called in a loud voice. "Is that young man thar yet?" Back came the answer: "No, Ma, but he's gettin' thar."

Consolation Prize

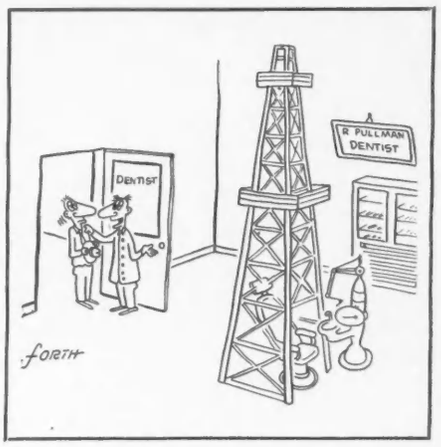
"Why do men have hair on their chests?"

"Well, they can't have everything."

Hole In One

A spinster, upon inheriting a rooming house, found that she could not make ends meet. Her first attempt to balance the books was to change the bed sheets less frequently, but to no avail. Next, she changed the towels less often, but this didn't help balance the books.

Other efforts failed to provide a sound operating basis, and in a last attempt to reduce the overhead, she determined the number of sheets of toilet paper used per customer, and asked them to use less. She placed an impressive sign over the toilet paper rack, requesting the guests to use only ten sheets. Still the budget failed to balance. The sign was changed limiting the number of sheets to eight. This also failed. The spinster, determined to balance the budget, changed the sign limiting each guest to six sheets. Upon cleaning the bathroom the following day, she was amazed to find that someone had added to her sign the question: "What the hell is par for this hole, anyway?"



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4. **MAXIMUM PENETRATION** of bullets into the formation, as proved repeatedly in competitive field tests.
5. **GUNS TO FIT EVERY CONDITION.** McCullough employs more than 30 different types and sizes of guns.
6. **ALL SIZES OF BULLETS** from $\frac{1}{8}$" dia. up to $\frac{3}{4}$" dia., to fit every possible need.
7. **BURRLESS BULLETS,** giving a completely burr-free hole, eliminating casing scraping, with *no* sacrifice of penetration.
8. **NO LOST TIME.** McCullough's simpler, lighter equipment cuts setting-up and moving-out time, speeds up every job.
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Flashes from the BEACON

WHEN BEACON Staff Artist David Hunt gets a wild look in his eye and grabs a pencil, we know another "BEACON Original" is a-brewin'. Dave, often in partnership with Record Columnist Roy Parmenter, dreams up a page of original cartoons each month for the liveliest company magazine you ever saw.

* * *

DAVE DOES serious work, too, as those of you know who have seen his spirited drawings of Denver and Kansas City landmarks, which accompanied the feature stories on these cities in recent issues of the BEACON. Suspecting that our "Parade of Cities" would produce a "run" on our magazine supply, we coaxed the pressmen into running a few extra copies of these issues (February through June). If you want any of these beautifully illustrated stories, just say so when you place your name on the BEACON mailing list.

* * *

OUR BEACON MAILBAG never fails us. No matter how low we feel in the morning, the day's mail can be counted on for a laugh, a smile, or a far-away look. In the far-away look department came a welcome glimpse of the past in a recent letter from the president of a machine company in Bartlesville, Oklahoma. The BEACON he had just received made him remember his old friend W. G. (Daddy) Bryson so vividly, he sat down and shared some of those memories of the late BS&B founder with us.

* * *

SINCE WE have been running a short story in each issue of the BEACON our mailbag bulges daily with manuscripts from every state. Authors in Canada, England, and France have also been kind enough to let us see their work. Of course, only the most interesting, timely, and "human" appear in the BEACON, but we enjoy reading all of them.

* * *

The BS&B BEACON is mailed without charge to those who enjoy it. A request on your company letterhead will do the trick.

Write to:

BLACK, SIVALLS & BRYSON, INC.

Industrial and Public Relations Division
720 Delaware
Kansas City, Missouri

SQUEAKS from the BULLWHEEL

In the Spotlight

Two Irishmen landed in America and took a room in a seaside hotel. To their surprise, they were attacked by mosquitoes, an insect new to them. Bewildered, they turned out the lights and crawled under the sheets. Larry looked up just as a firefly flitted in through the window. "It's no use, Mickey," he groaned. "They've come back looking for us with lanterns."

At Least, No Red Herring

"What is a Communist?"

"A fellow who borrows your pot to cook your goose in."

Pleased to Meet You

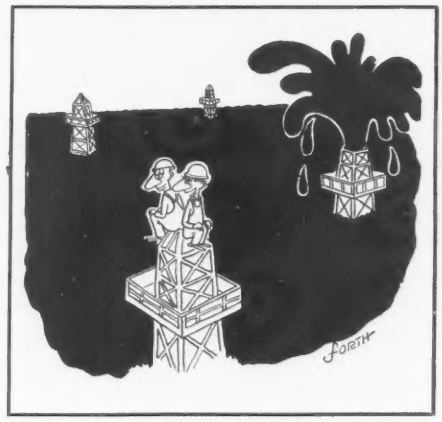
Two men worked side by side in a large office. They never spoke, but each watched the other. One man quit work daily at 4 o'clock. The other toiled until 6 or later.

Some weeks passed. Then the harder working of the two approached the other.

"I beg your pardon," he said. "Do you mind telling me how you clean up your work every day at 4 o'clock?"

"Not at all," said the other man. "When I come to a tough piece of detail, I mark it, 'Refer to Smith.' I figure that, in an outfit as large as this, there is sure to be a man named Smith. And I must be right; none of those papers comes back to me."

The harder worker started to remove his coat. "Brother," he said, "prepare for action. I'm Smith."



"That could be the biggest well we've hit yet!"

Service Man

He: "I come to bring warmth and light into the bleakness of your home."

Romantic Spinster: "Oh, you dear—"

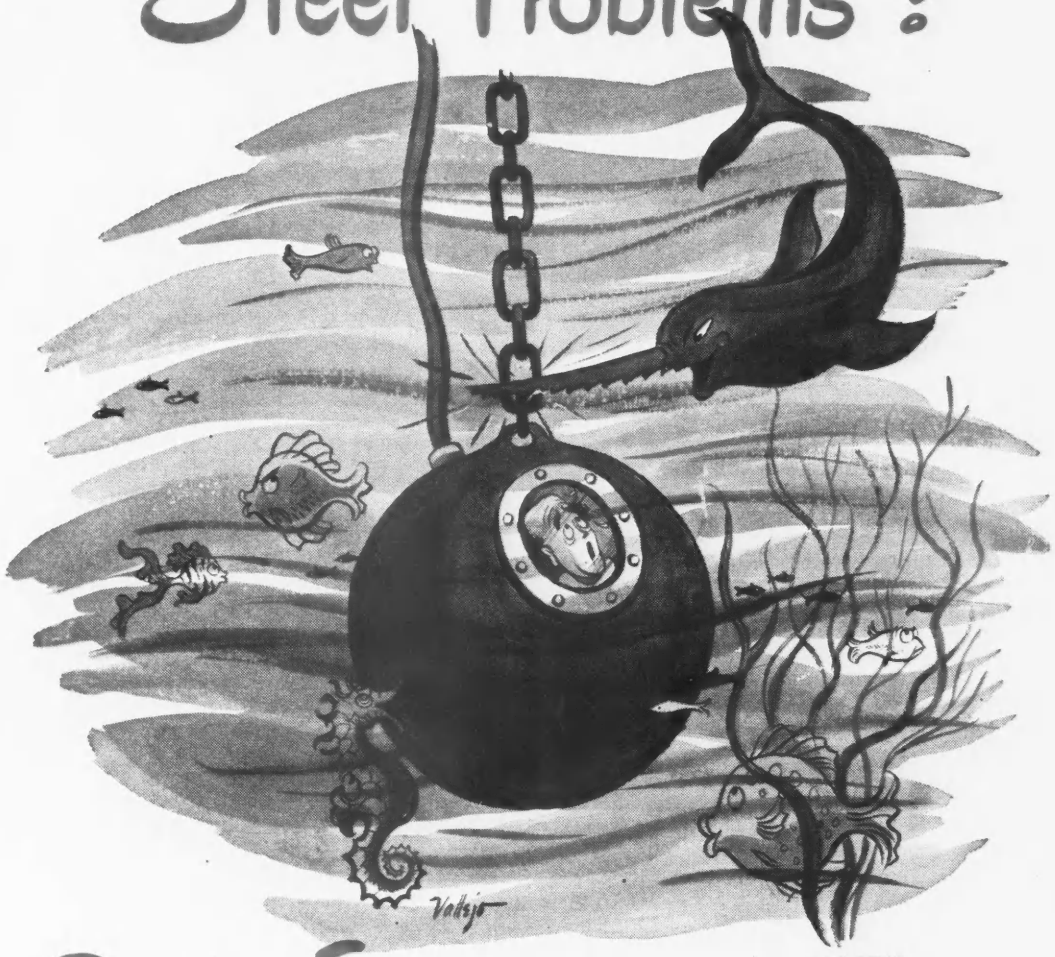
He: "Nix on the love stuff, old lady. I'm the installation man for the gas company.

Proof

When a woman driver puts her hand out, you may be sure of one thing—the window is open.

DUNNO' WHAT'S AT 4732 FEET— BUT EVERYTIME WE REACH IT, THE CHART PEN SQUIRTS OIL ALL OVER THE CHART !!
LANE O WELLS
RADIOACTIVITY WELL LOGGING
HUBERTMAC
CR-204

Steel Problems?



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Use the *right* steel for the job and avoid that sinking feeling that comes from not knowing for sure whether the steel *is* right. In addition to the common carbon steels such as structurals, plates, sheets, etc., Jorgensen maintains complete warehouse stocks of alloy, stainless, tool and specialty steels. The one best steel for your particular application can be delivered to you promptly. *CALL JORGENSEN FIRST!*

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On this and three other wells the Brewster N-7 Team shown here functioned smoothly and efficiently, with no downtime due to mechanical failure.

The N-7 Drawworks was brought to the site in one load.

Rigging up was accomplished quickly and easily.

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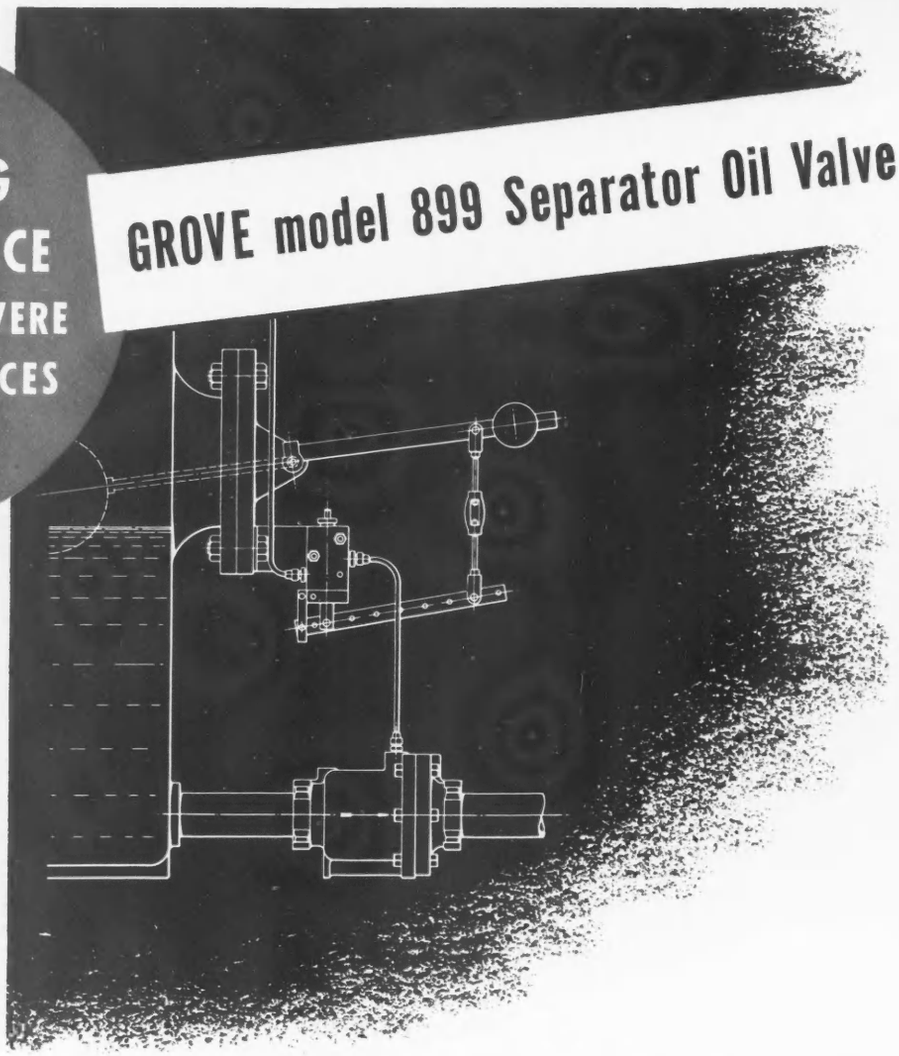
GROVE model 899 Separator Oil Valve



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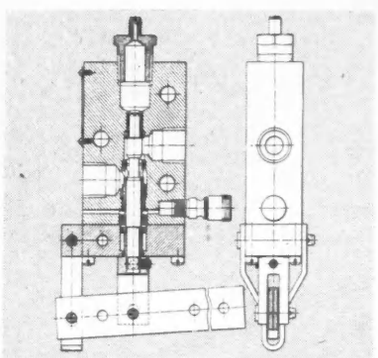
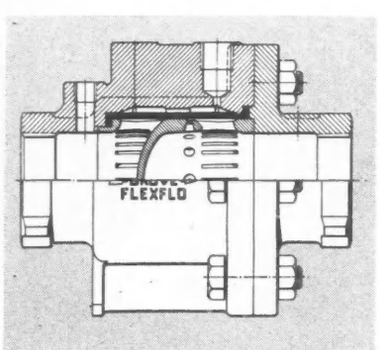


Section of Full Stroke Operator.



Sectional view of Flexflo Valve.

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The Full Stroke Control Valve is a 3-way Seat-Seal valve, designed so that one port must close completely before the other opens. No throttling pressure can be applied to the Flexflo jacket . . . the Flexflo will always be either fully open or tightly closed.

On rugged services, handling the most gritty and abrasive fluids, Grove Separator Oil Valves outlast all others and cut maintenance costs to the bone. Wire, write or call your nearest Grove representative today—ask for full information on the Model 899.

GROVE REGULATOR COMPANY
65th & Hollis Street Oakland 8, Calif.

Factory Branches: 3608 Navigation Blvd., Houston, Texas; 1930 W. Olympic Blvd., Los Angeles 6, Calif.

GROVE

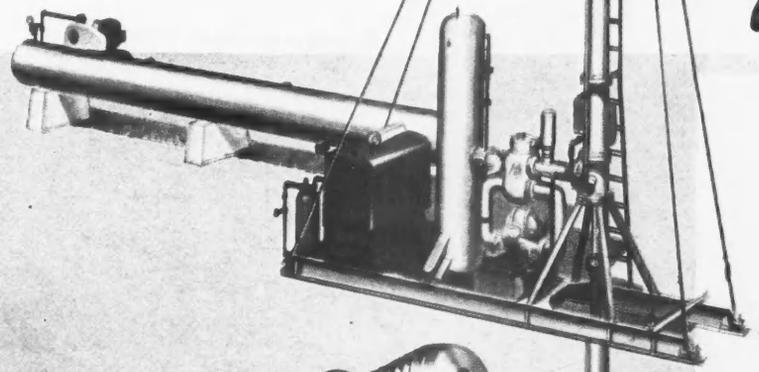
GROVE
SIMPLICITY
ACCURACY
SAFETY
"PUTS PRESSURE TO WORK"

MODEL 899
Separator
OIL VALVE

AXELSON FIRST CHOICE *for all three*

AT THE SURFACE

The Axelson Hydraulic Long Stroke Pumping Unit produces more oil at less lifting cost because its long smooth stroke with few stroke cycles per minute combine with easy cushioned reversals to decrease stretch loss and cut sucker rod failures to an absolute minimum. Greater pumping capacity at greater depths, together with low maintenance costs and easy operation, are proving the value of the Axelson pumping unit to oil operators throughout the nation.



IN THE TUBING — Axelson duty-designed, service-proved, end-to-end normalized Sucker Rods with guaranteed minimum physical and chemical properties, backed by 56 years of manufacturing know-how, are your assurance of top performance.

AT THE PRODUCTION LEVEL — Axelson deep well plunger pumps deliver more oil at less lifting cost with less down time. There is an Axelson deep well plunger pump for every specific pumping condition.

OIL FIELD PRODUCTION EXECUTIVES AGREE — Axelson plunger pumps, sucker rods and Long Stroke Pumping Units set the quality and dependability standards for the entire petroleum producing industry. Fifty-six years of designing, manufacturing, selling and servicing deep well pumping equipment guarantees Axelson to be the top name for top production.

PRODUCTION FOREMEN AGREE — When Axelson equipment is on the lease, unquestioned reliability and peak performance are assured. Production men know Axelson deep well pumping equipment from long experience. To keep the fluid column moving with less down time, they specify Axelson.

FIELD CREWMEN AGREE that petroleum recovery equipment marked with A will produce more oil, operate longer, give less trouble, under all well and pumping conditions. Axelson maintains conveniently available stocks in most fields throughout the world to give rapid service and help to eliminate costly delays.

***WRITE TODAY** for the complete 98-page Axelson catalog giving full details on the world's finest line of deep well pumping equipment!*

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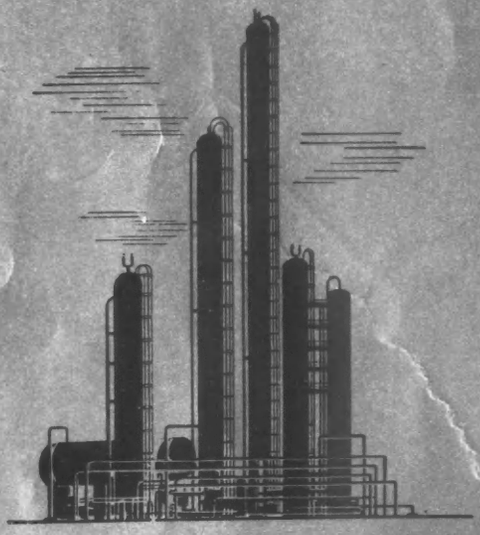

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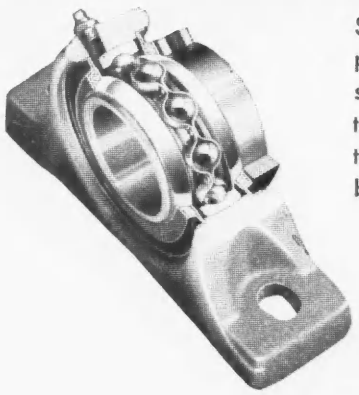
THE HUDSON organization, qualified by years of experience in the successful design, construction and operation of major hydrocarbon processing plants, offers its specialized services for projects in any part of the world.

LINK-BELT offers the "QUALITY QUINTET" in BALL AND ROLLER BEARINGS

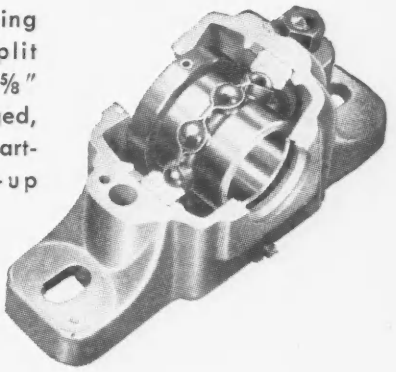
Series 200 ball bearings



Solid or split housing pillow blocks (solid shown) for shafts 5/8" to 3 15/16"—also flanged, take-up, and hanger blocks.

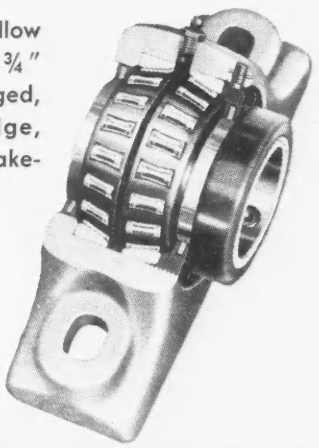
Series 300 ball bearings

Solid or split housing pillow blocks (split shown) for shafts 5/8" to 3 15/16". Also flanged, flanged cartridge, cartridge and take-up blocks.

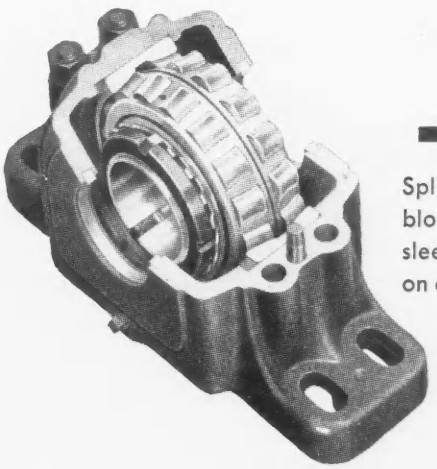


Series 400 roller bearings

Solid housing pillow blocks for shafts 3/4" to 4"—also flanged, flanged cartridge, cartridge and take-up blocks.



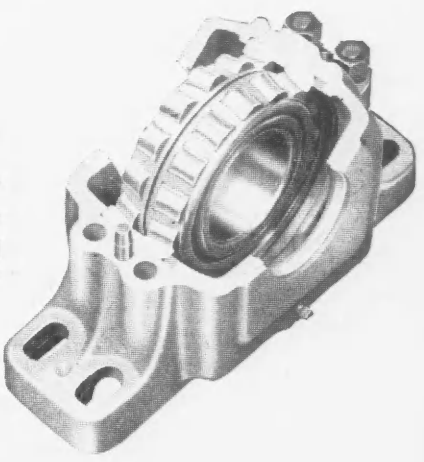
Series 6800-6900 roller bearings



Split housing pillow blocks with adapter sleeves for mounting on commercial shafting of 1 7/16" to 6 15/16" diameter.

Split housing pillow blocks for press-fit on precision-turned shafting of 1.7700" to 7.4800" diameter.

Series 7800-7900 roller bearings



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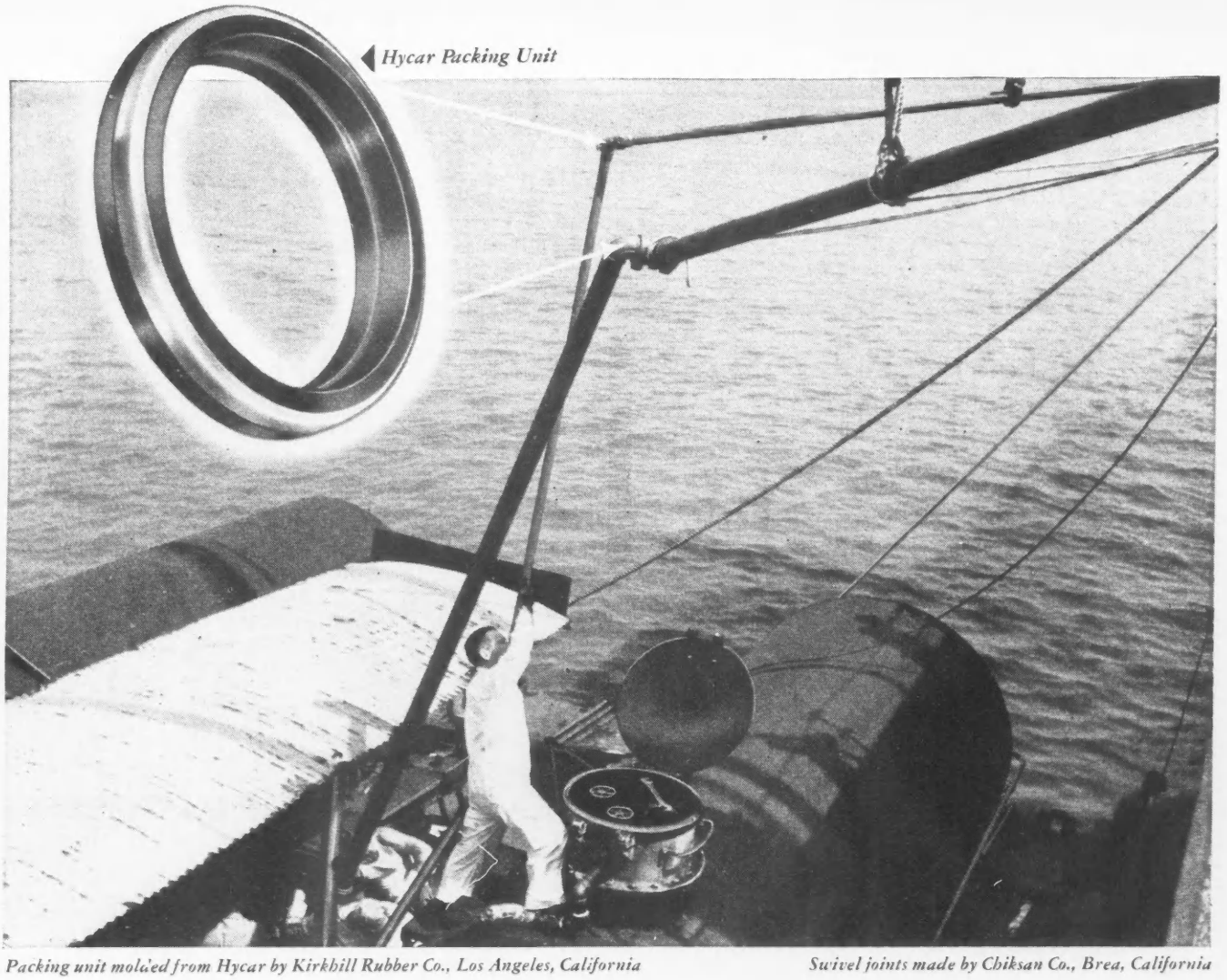
LINK-BELT BALL AND ROLLER BEARINGS

◀ *Hycar Packing Unit*



Packing unit molded from Hycar by Kirkhill Rubber Co., Los Angeles, California

Swivel joints made by Chiksan Co., Brea, California

How to twist a pipe, yet keep it leak-proof

TRANSFERRING liquified petroleum gas from tank cars to ships used to be a tough job. Discharge pipes couldn't be twisted or turned to hit the right spot, at just the right angle.

But an easy way to do the job was found after two tricky problems were licked. One problem went by the boards when the Chiksan Ball Bearing Swivel Joint was developed. This unique joint makes it possible to twist and turn pipe to just about any angle. The other problem—leak-proofing the joint—was solved with a packing unit made with Hycar American rubber.

The Hycar Packing Unit, a flexible seal between the metal parts, exhibits minimum volume change under service conditions. It effectively stops leakage of gas or liquid flowing from one section to another. Swivel joints are used successfully wherever gases or liquids are transferred or transported—such as refineries, chemical plants, dairies, food processing plants, bottling works and canneries.

Hycar was chosen for the leak-proofing job because it has such a wide range of qualities. It is resistant to oil and gas, abrasion, and does not flow even under extreme pressures. Hycar compounds can be varied from extremely soft to bone hard, and made in many colors.

Hycar may be just what you're looking for to answer a problem . . . to make better, more saleable products. For Hycar is used as a base material . . . as a plasticizer for vinyl resins . . . as a modifier for phenolics . . . as an adhesive base . . . as a latex for coating or impregnating. Send for complete information. Just write Dept. HF-10, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

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American Rubber

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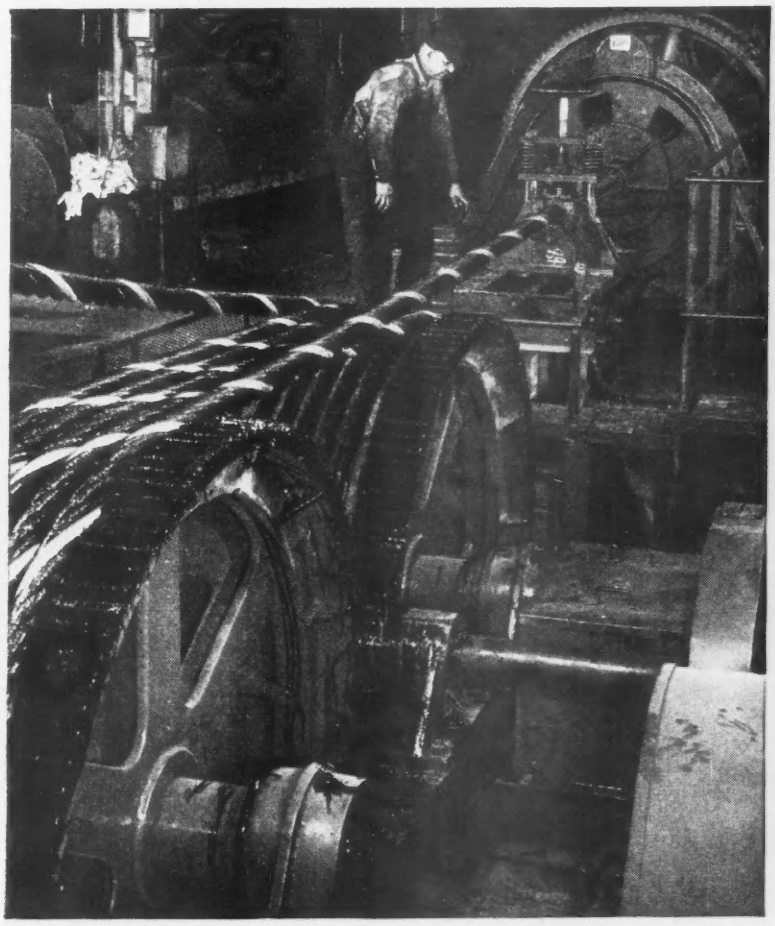
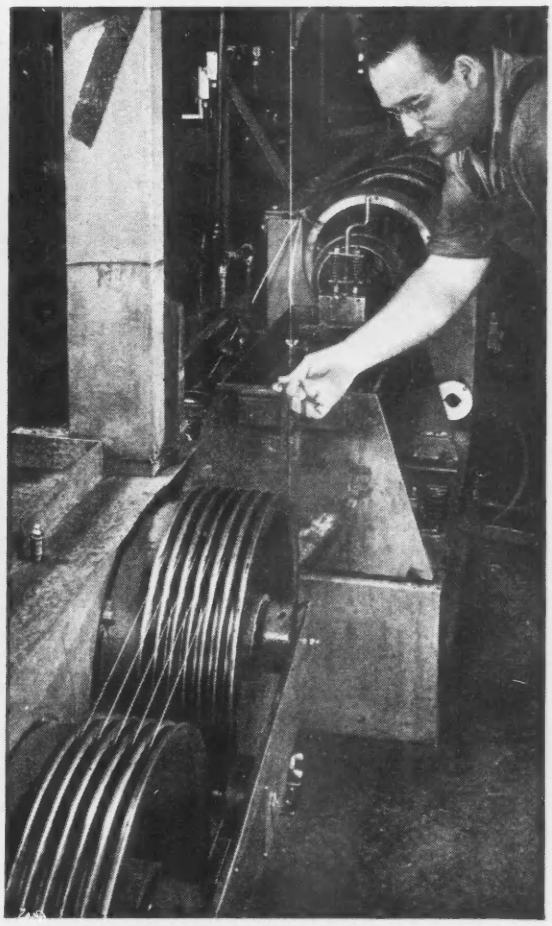
WORLD OIL, published every month except semi-monthly in February. Entered as *The Oil Weekly* as second class mail matter December 23, 1916, at the post office at Houston, Texas, under the act of March 3, 1879.

This photograph shows a 3⅛" diameter Monarch Whyte Strand Wire Rope coming off a Macwhyte closing machine. Weight of this rope is approximately 16.65 pounds per foot. It has a strength of approximately 392 tons and is used for the digging line on large dragline excavator with 35 cu. yd. bucket.



In this photograph is a 3/64" diameter Stainless Steel Cord coming off a Macwhyte closing machine. It weighs approximately 0.35 lbs. per 100 feet; has a strength of approximately 270 pounds, and is used for many small cord needs.



Whether you need

LARGE WIRE ROPE or SMALL WIRE CORD

make your selection from

You will get smoother operation and better service when you use the wire rope designed and manufactured to meet your requirements.

Macwhyte engineers are always glad to suggest the correct Macwhyte rope or cord best suited to your needs.

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584

HIGHLY PORTABLE POWER

FOR SERVICING or WORK-OVER DUTY

Premier Well Service, Inc., Houston, Texas, operates this drilling rig powered with two Waukesha 6-NKU units. Their units combine great power with a high degree of portability. That's why so many operators throughout the oil fields use them, especially for portable servicing and work-over jobs. Operating here on natural gas each Waukesha 6-NKU is equipped with a 4-cylinder Waukesha ICK gasoline starting engine, and a belt-driven air compressor, directly behind the radiator, for operation of air clutches and controls on the rig transmission.

Waukesha Model 6-NKU unit has a box base and separate radiator. Its 6-cylinder, 7-in. x 8½-in., 1962 cu. in. engine operates on 1000 Btu. gas or butane and develops peak of 225 hp. for momentary overload, and 173 hp. continuously at 1050 rpm. Its renewable wet type cylinder sleeves, positive drive water pump, overhead valves, 7-bearing crankshaft, full pressure oiling, precision bearings are detailed in Bulletins 1136 and 1122.

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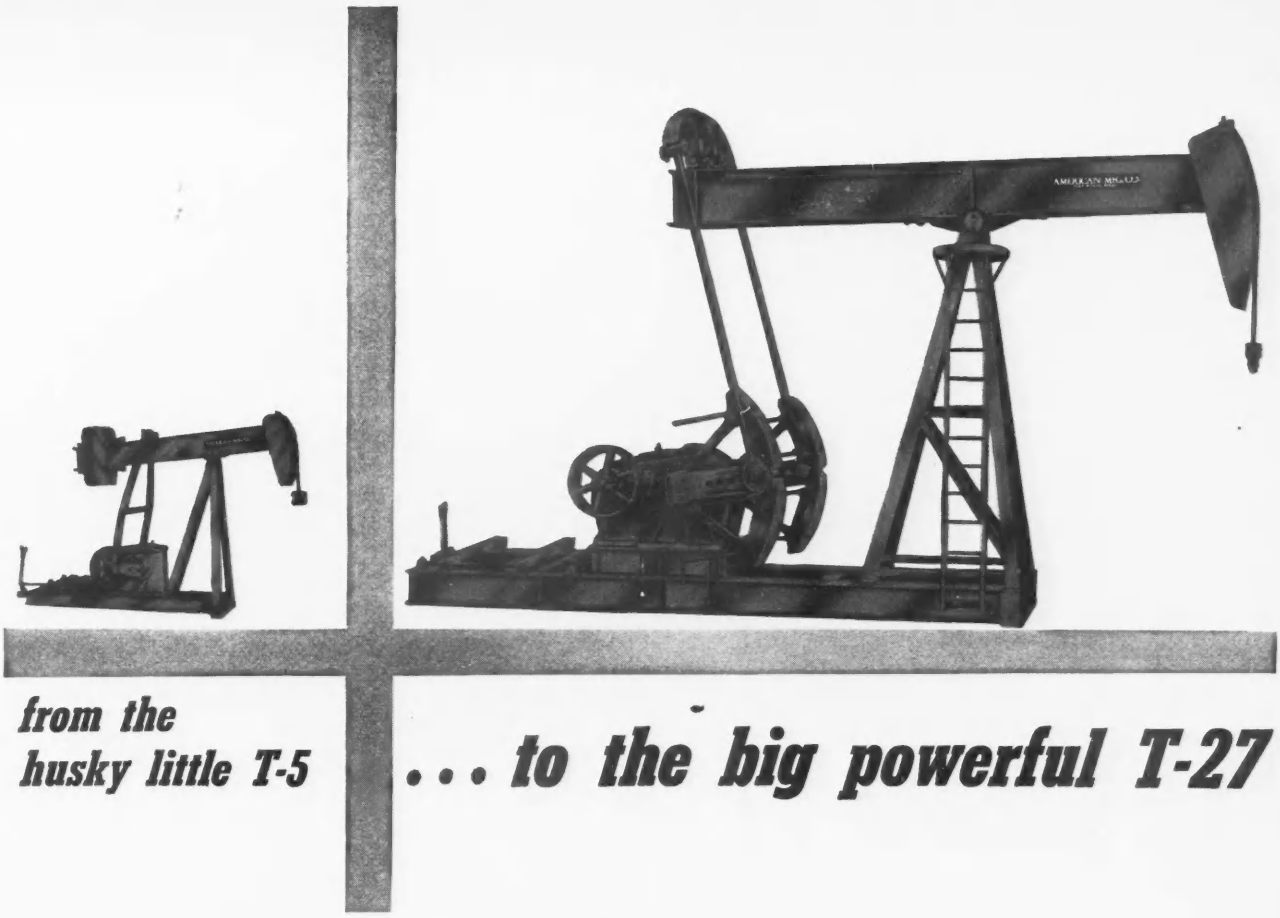
WAUKESHA
OIL FIELD POWER



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... reduce pumping costs

Whether the job is large, small, or in-between, there is an American Pumping Unit the right size to give longer service with less servicing. Various combinations of structures and reducers make available a wide range of Units from which the most economical application can be selected.

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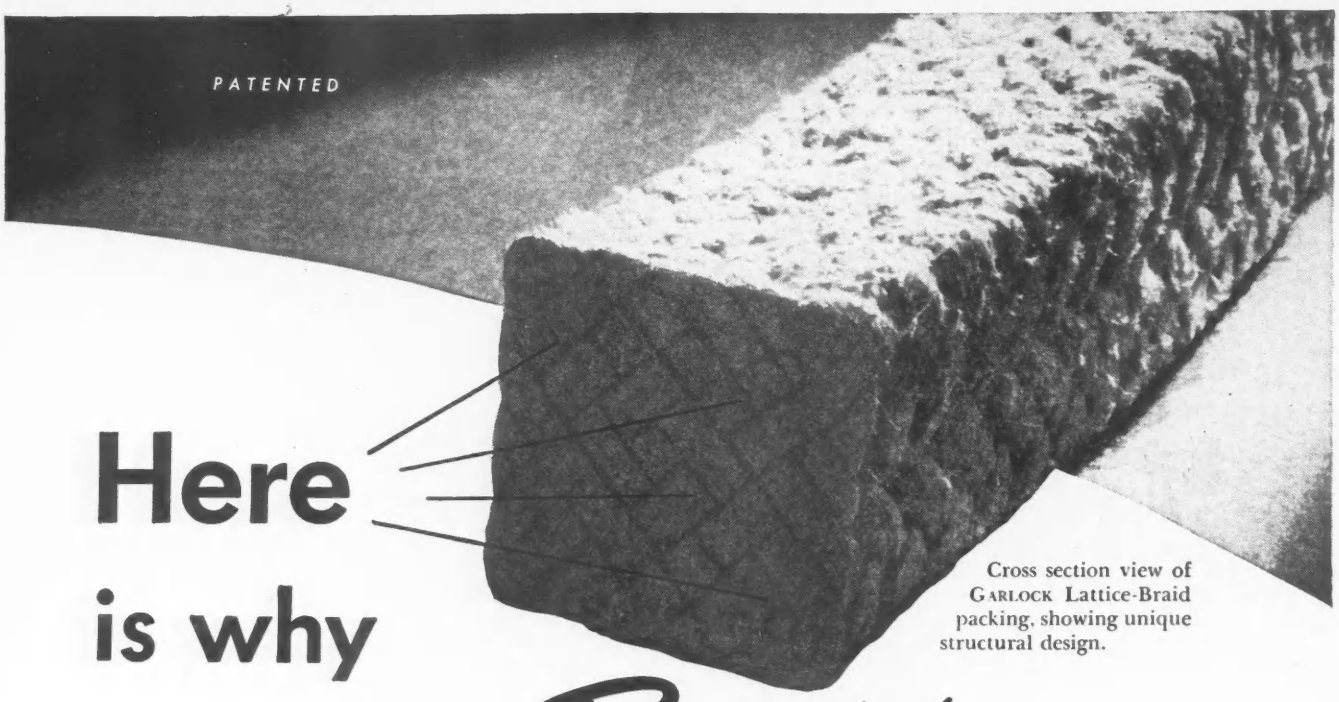

Cross section view of GARLOCK Lattice-Braid packing, showing unique structural design.

Here is why Lattice-Braid Lasts Longer

ASBESTOS

GARLOCK 730—for hot or cold water at medium to high pressures.

GARLOCK 731—for steam, gases or water at temperatures up to 700° F.

GARLOCK 732 (wire inserted)—for heavy duty service against steam, oil, gases or water at temperatures up to 700° F.

GARLOCK 733—for hot or cold water or alcohol at medium or low pressures.

GARLOCK 734—for cold gasoline, kerosene and light oils.

GARLOCK 736 (blue asbestos)—for concentrated mineral acids.

FLAX

GARLOCK 740—for cold water at medium or low pressures.

GARLOCK 745—for heavy hydraulic service against cold water.

COTTON

GARLOCK 751—for hot or cold water.

The individual strands are braided *through and through* in an entirely different way by specially built braiding machines designed exclusively for manufacturing Garlock Lattice-Braid packing.

All braided strands are strongly lattice-linked together into a structural unit which holds together even when the packing is worn far beyond the serviceable limits of wear of ordinary braided packings.

The unique structural design of Garlock Lattice-Braid packing also provides unusual flexibility and built-in controlled porosity which imparts semi-automatic action and keeps the packing properly adjusted in the stuffing box.

Write for folder!

THE GARLOCK PACKING COMPANY
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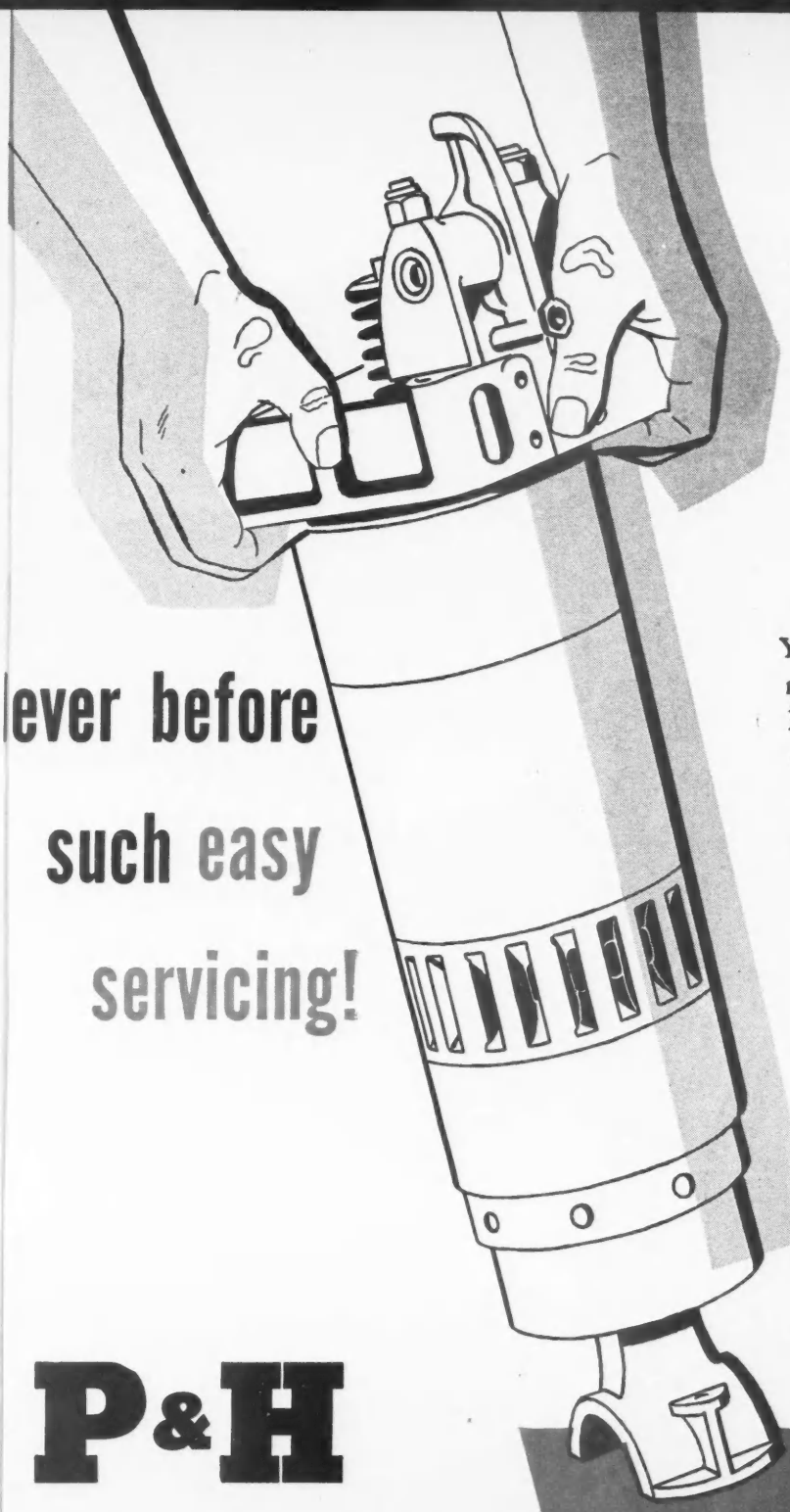
Los Angeles, Calif.

GARLOCK Lattice-Braid PACKING



lever before such easy servicing!

Yes, days of servicing or overhaul time are now shortened into hours with the new P&H Diesels. Cylinder head, liner, piston and rod assembly is quickly removed as a unit — without disturbing engine mounting — without even dropping the oil pan.

These complete cylinder assemblies are interchangeable, permitting transfer from one engine to another. It can be done right in the field. Lost operating time is cut to a minimum. Literature on request. Address Harnischfeger Corporation, Diesel Division, Port Washington, Wis.

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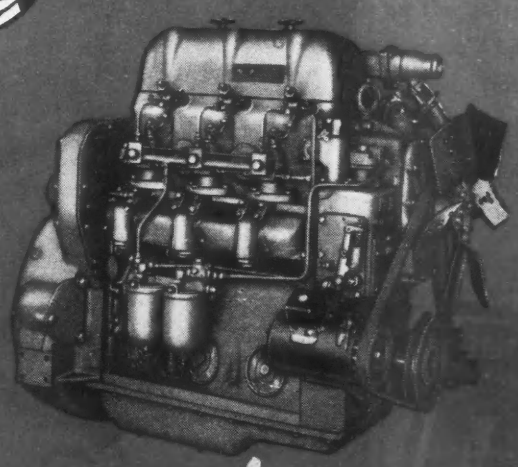
P&H DIESEL ENGINES

2-CYCLE

P&H Diesels are simplified, compact power units with low weight per horsepower. They are designed to withstand the severe power demands of excavator service. They have proved themselves in that service—are now ready for *any* service.

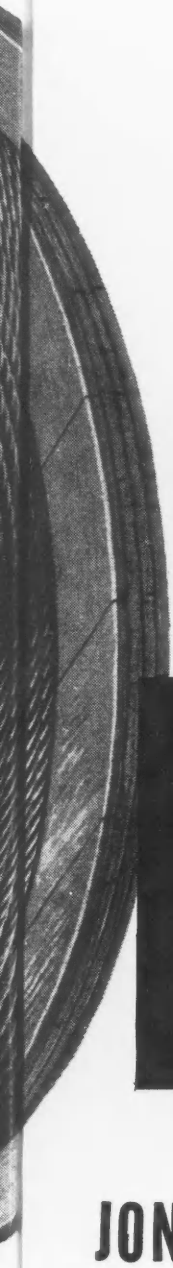


Model 387-C. 3 cylinder

Get the

Yours for the asking is this interesting book on wire rope. Among other things it tells how proper care and servicing cuts rope costs. Get your copy at your Jones & Laughlin Supply store or write us at Tulsa. Ask for "WIRE ROPE IS A MACHINE."

Rope that lasts so much longer



J&L STEEL

Yes, there are reasons. J&L Precisionbilt Wire Ropes last so much longer because they are manufactured to new high standards, under the most exacting metallurgical and fabricating controls. The wires are drawn from very special steel to precise uniformity. You even get plus value in a special lubricant which combats corrosion. Get the benefits of higher speeds with greater safety, and lower ton-mile costs with unqualified approval from the men on the derrick floor. Rig up NOW with J&L Precisionbilt Wire Rope and we'll be content to let your own records sell subsequent installations. Your nearby Jones & Laughlin Supply store has the rope to fit your work and equipment. Let's go!

JONES & LAUGHLIN SUPPLY COMPANY

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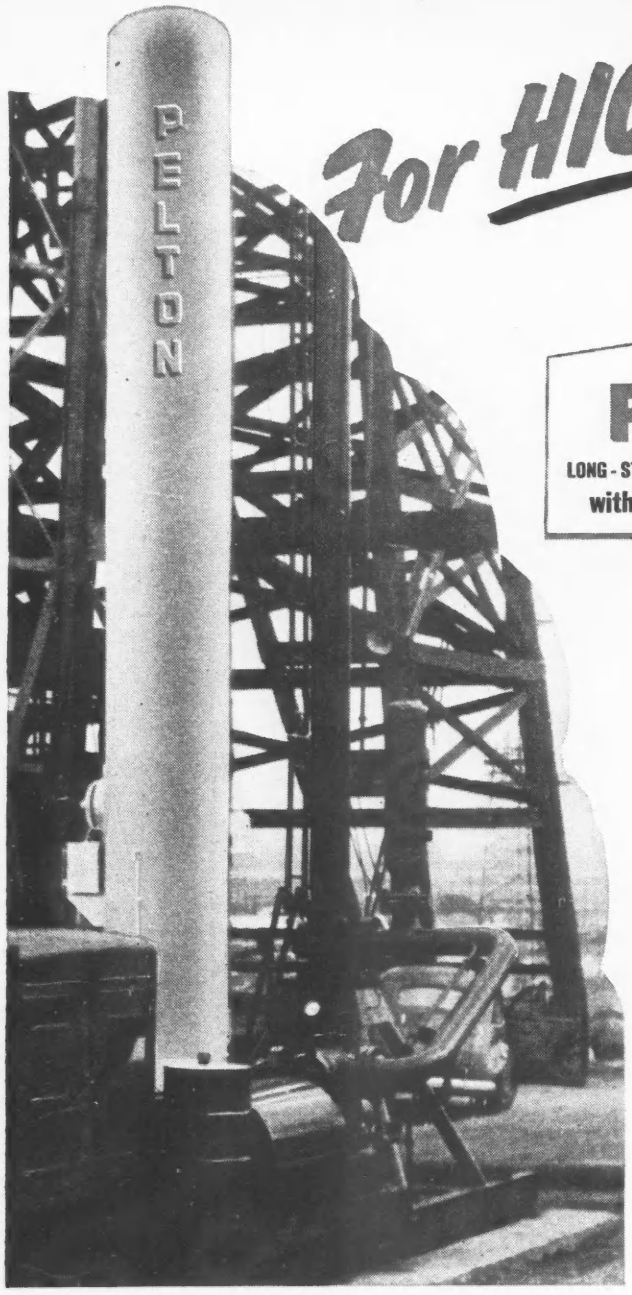
For HIGHER Production in corrosive wells...



PORTABILITY PLUS PERFORMANCE. Mounted on a single portable skid, this Pelton Series A-P jack has a 20-foot constant velocity stroke and full hydraulic reversal control. A multiple-valve port permits instant stroke variation without stopping the jack. Bottom hole pump spacing, too, can be changed during operation.

In addition to other advantages (all fully covered in Bulletin No. 38, available on request), the long slow stroke of the Pelton jack is said to increase volumetric efficiency of the bottom hole pump by lowering fluid velocities through the standing valve. At the same time it reduces tendency to gas-lock.

Designed and equipped for long, trouble-free performance in deep and corrosive wells, Pelton jacks are supplied with Monel polished rods with load ratings from 20,000 pounds to 40,000 pounds. *Photograph and operating data courtesy of The Pelton Water Wheel Company, Inc., San Francisco, California.*

install a

PELTON

LONG-STROKE HYDRAULIC PUMPING JACK with "MONEL" Polished Rods

Logged records prove it! The Pelton jack with MONEL* polished rods keeps production *up*—and downtime *down.*

But that's not all!

Pelton's 20-foot constant velocity stroke with fewer and softer controlled rod reversals leads to longer life for sucker rods and bottom hole equipment.

Monel polished rods are supplied for severe service with Pelton jack models that cover a range of polished rod load ratings from 20-40,000 pounds.

Because of their high tensile strength and exceptional toughness, Monel polished rods can be used – with ample safety margin – in any depth well. They never rust. They're highly resistant to wear and abrasion. They stand up under the corrosive action of brines, crudes and hydrogen sulfide.

What's more, Monel polished rods hold their original hard, smooth surfaces. They don't pit, don't tear packing.

In short, the use of Monel polished rods in the Pelton jack insures extended equipment life. And at the same time, you're pumping *more* oil at *lower* cost!

*Reg. U. S. Pat. Off.

FOR COMPLETE INFORMATION . . .

. . . about the many special features of the Pelton Long-Stroke Hydraulic Jack with Monel Polished Rods, write THE PELTON WATER WHEEL COMPANY, INC., 2929 Nineteenth Street, San Francisco 10, California. Just ask for *Bulletin No. 38.*

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Manhattan's New Rotary Hose and Built-in Coupling . . . are earning the Tool Pusher's Preference

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A new conception of rotary hose construction gives RAY-MAN the super-flexible qualities demonstrated by the loose, supple coils illustrated here. Tool pushers make up Ray-Man Rotary Hose to swivel and stand pipe easier and quicker than ever before. It's also easier to transport from hole to hole. The hose suffers less stress and damage—lasts longer.

TYPE E BUILT-IN COUPLING

The new, streamlined coupling on Ray-Man Rotary Hose also contributes greatly to easier handling and freedom from accident. It's a lighter weight, full-flow coupling with no projecting flanges. The "Lip-Lok" Pressure Sealing feature is a new safeguard against costly leaks and blow-outs.

Made in 5,000 lb. test pressure for Ray-Man Rotary Hose and 4,000 lb. test pressure for Paranite Brand.

SIX MAJOR IMPROVEMENTS IN CONSTRUCTION

. . . make this combination your best buy.

1. Is extremely flexible
2. Holds steady in the derrick—resists pulsation under pressure
3. Lasts longer because of balanced, engineered construction
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5. Has G. O. P. Flexlastics tube for all methods of drilling, including drilling-in with oil or oil-base mud
6. Has new Built-In Coupling featuring "Lip-Lok" leakproof seal

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RAYBESTOS-MANHATTAN, INC.

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These Vital Parts fit *ALL* GM "71" DIESELS

Every GM Series 71 Diesel engine, whether a two-cylinder or one of a Quad 6, *has the same bore and stroke.* This means that practically all moving parts are exactly the same for any size Series 71 engine from 43 to 520 continuous B.H.P.

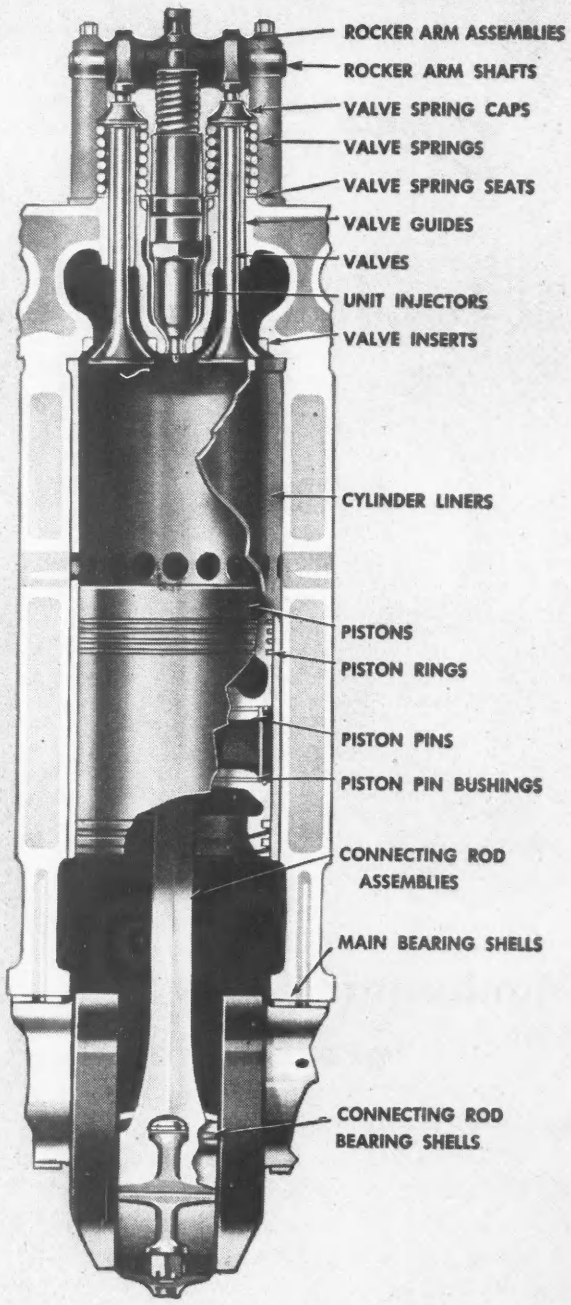
For example, all of the GM Diesel parts shown here, plus dozens more, are completely interchangeable, regardless of the number of cylinders, horsepower, age or usage of the engine.

To large contractors, oil drillers, truck or boat fleet operators, this unique feature of GM Diesel design means lower parts inventories and less time out for maintenance.

To the individual owner, it brings a no less important benefit. A *single* inventory of basic parts on the distributor's shelves increases the availability to owners of the *right* part when it is needed.

Maximum parts interchangeability is just one of the many *plus* values that go with your purchase of General Motors Diesel engines—a good reason why it pays to *standardize* on GM Series 71 Diesels.

For topmost satisfaction and reliability, always buy genuine "Factory-Engineered" GM Diesel parts from your authorized distributor or dealer.



CUTAWAY OF CYLINDER FROM GM SERIES 71 DIESEL

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES...*Up to 200 H.P.* **DETROIT 28, MICHIGAN** MULTIPLE UNITS...*Up to 800 H.P.*

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● You're set for speed when Republic Electric Weld Casing is stacked at your rig. This *modern* casing really helps hurry the make-up. Its long, straight lengths and its uniform roundness speed stabbing. Clean, full-formed threads spin-in and tong-up fast . . . and tight.

You'll land your string with complete confidence, too. Republic Casing is made of high ductility steel, fully normalized for uniform structure and cold sized for high yield strength. These qualities combine with uniform wall thickness and uniform roundness to make it tops for resistance to collapse. A uniform depth of tough steel under thread roots all around the pipe protects against pull-outs.

Yes, you'll hurry the make-up—and you'll get full protection underground —when you specify Republic Electric Weld Casing and Tubing.

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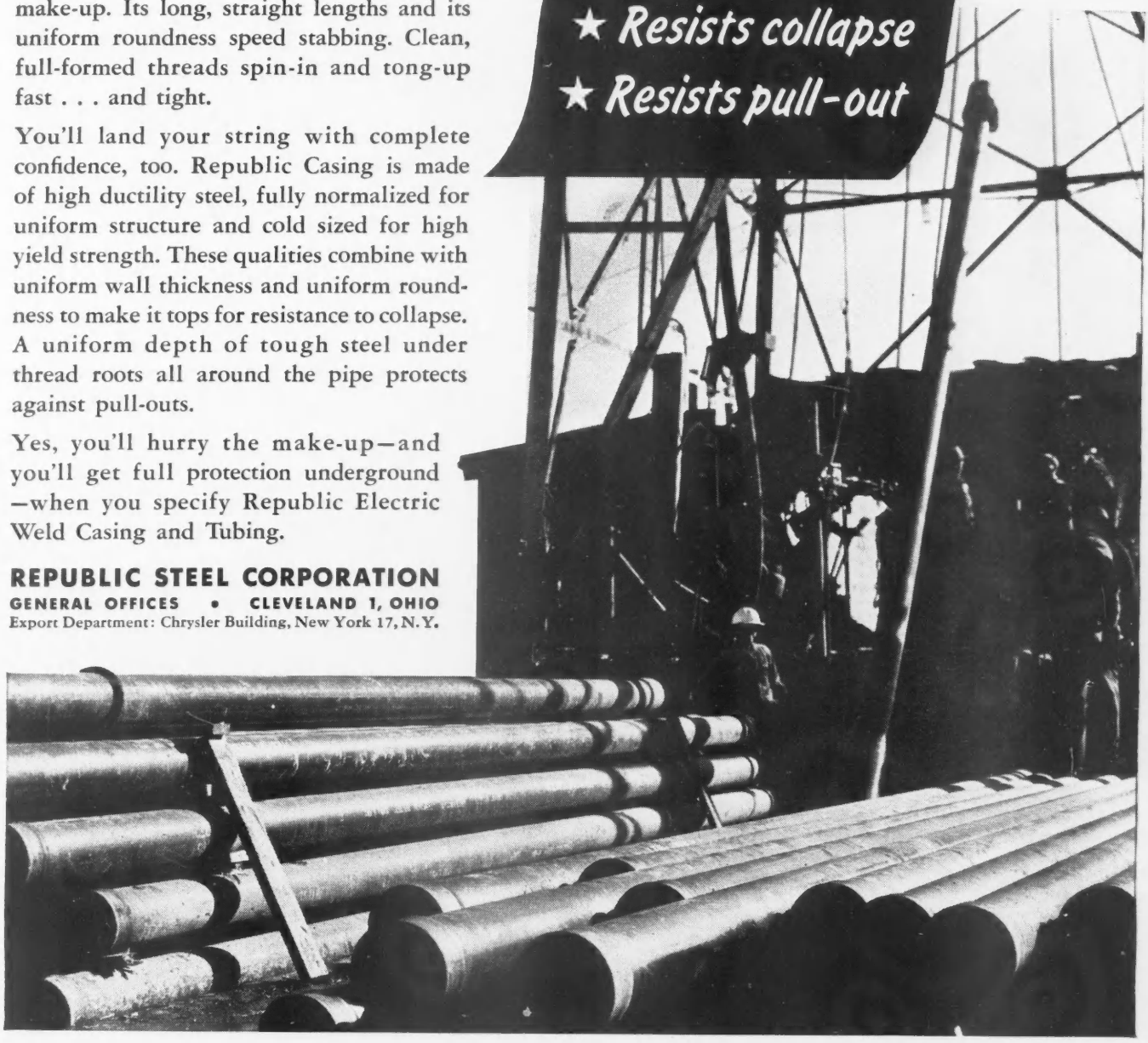
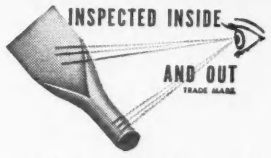
★ *Makes up fast*
★ *Resists collapse*
★ *Resists pull-out*





Republic Electric Weld Casing and Tubing are made from flat-rolled steel, both sides of which are inspected. Thus, the surface which becomes the inside wall is free from hidden defects.

REPUBLIC *Electric Weld* **NORMALIZED CASING AND TUBING**

REPUBLIC STEEL REG. U.S. PAT. OFF.

Other Republic Products include Line Pipe—Carbon, Alloy and Stainless Steels—Upson Studs, Bolts and Nuts—Electrunite Heat Exchanger Tubes

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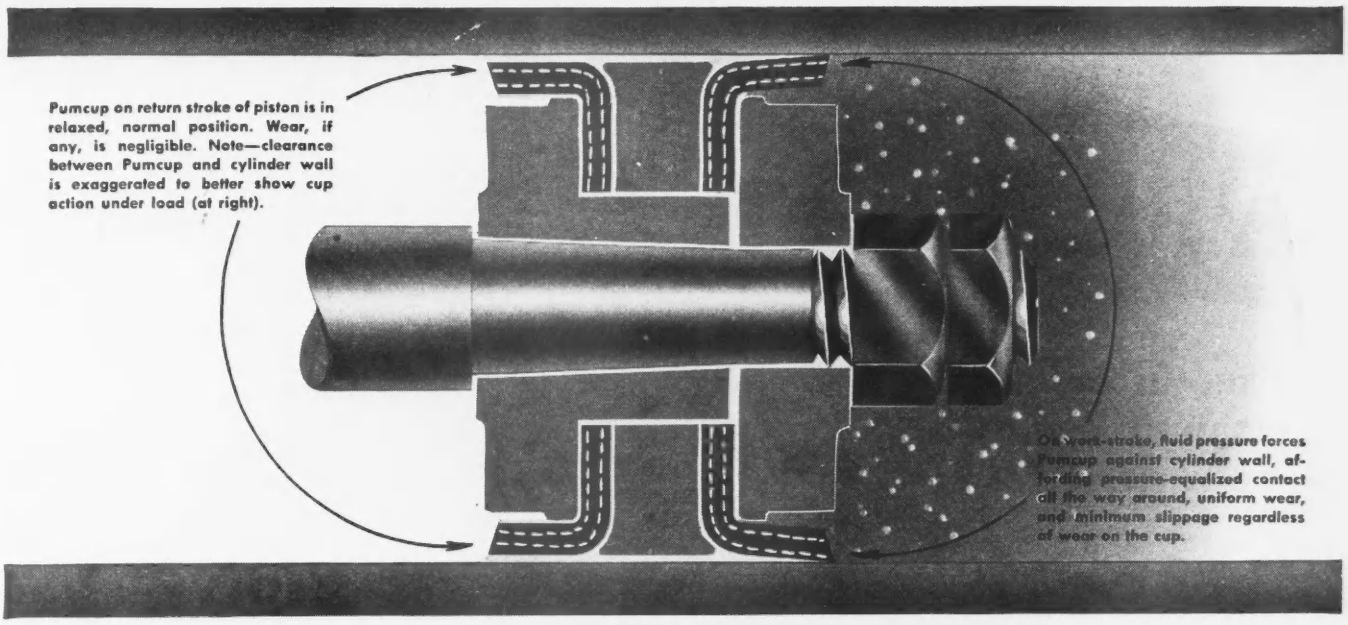
JAS. P. MARSH CORPORATION, Dept. K, Skokie, Illinois

THE MARSH BRANCH *plant at Houston offers shipment from stock and facilities for repairing all makes of gauges.*

MARSH GAUGES


Pumcup on return stroke of piston is in relaxed, normal position. Wear, if any, is negligible. Note—clearance between Pumcup and cylinder wall is exaggerated to better show cup action under load (at right).
On work-stroke, fluid pressure forces Pumcup against cylinder wall, affording pressure-equalized contact all the way around, uniform wear, and minimum slippage regardless of wear on the cup.
PUMP PISTON MOTION

NEW RETIREMENT PLAN...

for piston packing

WHAT is the "retirement age" of the piston packing in your reciprocating pumps, or in your air or hydraulic controls? A day? A week? A month?

Think what you could save in maintenance expense, in costly shutdowns, with a packing that does a perfect job 5, 10, or even 100 times as long. That's exactly what Darcova Pumcups are doing in thousands of installations where they have replaced leather crimps, ring packing, metal or plastic rings, or other ordinary packing.

How? First, the drawing above shows how the cup principle, scientifically applied the Darcova way, minimizes friction, equalizes and retards wear. Second, Pumcups are made of a special, Darcova-developed composition, exceptionally wear-resistant and immune to tough pressure and temperature conditions. Third, Pumcups are precision-built in many different textures, each absolutely uniform. Fourth, despite wear, high volumetric efficiency is retained for the life of the packing.

So, if you're not using Darcova Pumcups, you're in line for a new piston packing "retirement plan"—one that will save you plenty of time, trouble and expense. For a free bulletin containing complete information, write, or use the coupon below.

Darcova Pumcups are made in standard sizes from ½ to 42 inches in diameter, are easily installed in any reciprocating pump or air or hydraulic mechanism to replace ordinary packing. They handle virtually any fluid under a wide range of pressure and temperature conditions.

DARCOVA
THE ORIGINAL COMPOSITION CUP

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WILLIAMSPORT, PA.

Darling Valve & Mfg. Co., Williamsport 7, Pa.
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THE OIL MAN'S Calendar

SEPT.	
7– 9	Pacific Gas Association, Annual Convention, Santa Barbara, Calif.
12–16	National Association of Corrosion Engineers, Short Course on Corrosion, University of Texas, Austin, Texas.
14–15	Oil Industry Information Committee, Hotel Traymore, Atlantic City, N. J.
14–16	National Petroleum Association, Hotel Traymore, Atlantic City, N. J.
19–21	American Association of Oilwell Drilling Contractors, Ninth Annual Meeting, Baker Hotel, Dallas.
22–23	Louisiana-Arkansas Division Mid-Continent Oil and Gas Association, Annual Convention, Roosevelt Hotel, New Orleans.
24–27	American Institute of Mining and Metallurgical Engineers, Regional Meeting, Neil House, Columbus, Ohio.
24–28	National Safety Council, Morrison Hotel, Chicago.
25–30	American Institute of Mining and Metallurgical Engineers, Ohio Valley Section, Mid-Year Meeting, Neil House, Columbus, Ohio.
26–28	American Management Association (Personnel), Waldorf-Astoria, New York.
27–30	National Association of Corrosion Engineers, Annual Permian Basin Corrosion Tour, Midland, Texas.
28–29	Liquefied Petroleum Gas Association, Board Meeting, Cosmopolitan Hotel, Denver.
28–30	American Society of Mechanical Engineers, Fall Meeting, Erie, Penn.
OCT.	
2– 4	Independent Petroleum Association of America, Blackstone Hotel, Fort Worth.
2– 5	American Society of Mechanical Engineers, Petroleum Division, 1949 Petroleum Mechanical Engineering Conference, Oklahoma Biltmore Hotel, Oklahoma City.
3– 4	National Association of Corrosion Engineers, South Central Region Meeting, Adolphus Hotel, Dallas.
5– 7	American Institute of Mining and Metallurgical Engineers, Petroleum Branch, Fall Meeting, Plaza Hotel, San Antonio.
12	San Joaquin Valley Oil Producers Association, Midyear Meeting, Bakersfield Inn, Bakersfield, Calif.
12–13	Purchasing Agents Association, Southwest Purchasing Agents Conference, Shamrock Hotel, Houston.
13–14	Texas Mid-Continent Oil & Gas Association, Annual Meeting, Rice Hotel, Houston.
14	Natural Gasoline Association of America, Southern Regional Meeting, Tyler, Texas.
17–20	American Gas Association, Annual Convention, Chicago.
20–21	American Institute of Mining and Metallurgical Engineers, Petroleum Branch, Fall Meeting, Elk's Club, Los Angeles.
31	Independent Natural Gas Association of America, Annual Meeting, Baker Hotel, Dallas.
NOV.	
7	Pipe Liners Club, Annual Dinner, Blackstone Hotel, Chicago.
7– 9	American Petroleum Institute, 29th Annual Meeting, Stevens Hotel, Chicago.
17–18	Petroleum Electric Power Association, Annual Conference, Hotel Beaumont, Beaumont, Texas.

Nomads Chapter monthly meeting: **Los Angeles**, second Wednesday, Jonathan Club, B. M. Landis, Secretary, **Houston**, second Monday, Houston Club, E. L. Lorehn, Secretary. **Dallas**, first Monday, C. J. Berlin, Secretary. **Tulsa**, third Wednesday, Hotel Tulsa, G. W. Davidson, Jr., Secretary. **New York**, first Monday, Louis Sherry's, R. V. McIntire, Secretary.

WORLD OIL

CURRENT OUTLOOK SECTION

AND NEWS ANALYSIS

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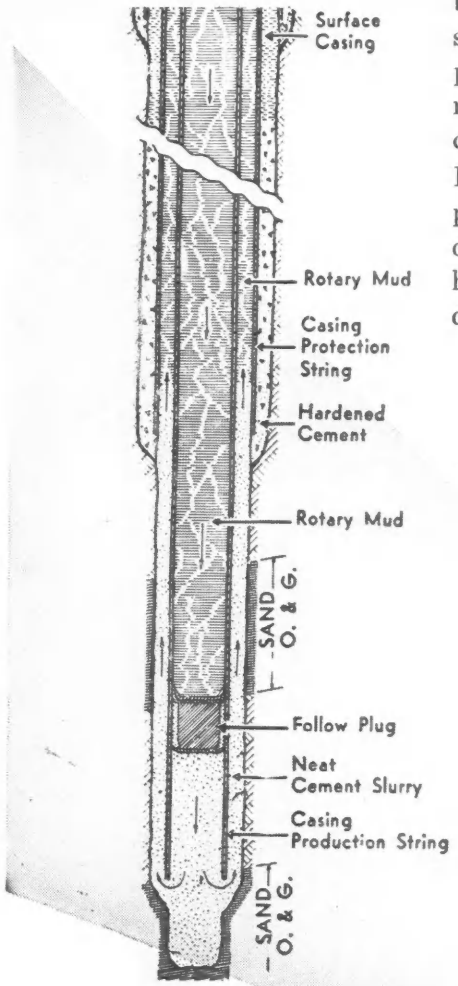

CONVENTIONAL CASING-CEMENTING OPERATION

Neat cement slurry being displaced from within suspended casing by pumping rotary mud.

In setting casing, the cement slurry must take the longest route possible before finally coming to rest. This trip is hazardous to the cement slurry every inch of the way. For a cement that makes a dependable seal back of the casing, despite mechanical difficulties, high temperatures and unforeseen delays, oil men rely on Unaflo. With its delayed, postponed, *retarded* set, Unaflo provides operators with ample time to form a good body of cement behind the casing. And it provides *extra* time to act in emergencies. After the period of retardation, Unaflo hardens normally to form a solid, impervious seal.

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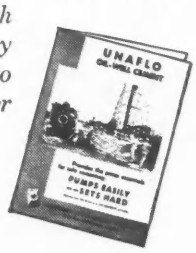

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